The Psychology of Learning

FORTY-FIRST YEARBOOK, PART II

THE FORTY-FIRST YEARBOOK

OF THE

NATIONAL SOCIETY FOR THE STUDY OF EDUCATION

PART II

THE PSYCHOLOGY OF LEARNING

Prepared by the Society's Committee

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EDITOR'S PREFACE

The Yearbook for 1942 could not be appropriately presented without mention of the distinguished editorial services of Dr. Guy M. Whipple, Secretary-Treasurer of this Society from 1915 until his death last August and Editor of twenty-six of the forty yearbooks heretofore published. While the content of these volumes is the work of hundreds of members of the profession, Dr. Whipple's technical skill and consistent adherence to high standards of workmanship have recorded their conspicuous imprint upon this widely accredited series of professional publications. It is an enviable privilege to succeed him in these offices and to record in this preface the acknowledgment of a professional obligation of long standing for his effective contributions to the plans and purposes of this organization.

The Forty-First Yearbook follows the plan of presentation of many previous yearbooks of the Society in the respect that it consists of two parts printed as separate volumes. It is unique in the sense that the two parts were from the beginning planned as companion volumes designed as scholarly expositions of the concepts of different schools of thought with respect to two fundamental issues in educational theory and practice. These issues pertain to the ultimate purposes of education in a democratic society and the nature of the learning process.

The projected aims of a social enterprise, even though they may be defined in terms of scientific knowledge, are the expression of a choice of alternatives. The final determination of such aims is the motive of philosophy. The effective methods to be employed in realizing selected objectives may most assuredly be disclosed through laboratory and other experimental techniques. Thus, in education, the issues involved in the determination of what knowledge is to be acquired are resolved by reference to the philosophical concepts with which the purposes and results of schooling are to be reconciled, while the methods by which this knowledge may be attained are to be sought in those refinements of experience achieved by the science of psychology in the testing of different theories of human learning. The companion volumes constituting the Forty-First Yearbook of this Society render noteworthy service to the profession of education by providing au-

thoritative commentaries on the educational implications of varying viewpoints among influential schools of philosophy and psychology.

The plan of this Yearbook grew out of the discussion of a suggestion by Dr. Bagley that provision be made for a yearbook affording a comparative treatment of the philosophical systems underlying present-day educational theories. Dr. Bagley's plan for such a yearbook was outlined in a letter to Dr. Whipple dated December 8, 1938. The proposal was presented to the Board of Directors at the meeting in Cleveland in February, 1939. The discussion of the proposed plan developed several suggestions by different members of the Board, including the suggestion that the effort be made to provide a companion volume affording similar treatment of psychological theories underlying educational procedures. The Board requested Dr. Bagley to meet with a preliminary advisory committee consisting of recognized leaders in the several schools of philosophy for the purpose of considering the possible development of a yearbook in this field. Dr. Freeman was requested to confer with a like committee with respect to the proposed volume in the field of psychology. Funds were appropriated to defray the expenses of these committee meetings.

When the Board met at St. Louis in February, 1940, Dr. Bagley presented a report on the deliberations of the advisory committee on philosophies of education. Varying opinions were expressed by the different members of this group. This report was supplemented by the reading of a letter from Professor Brubacher, one of the members of the advisory committee, in which the value of a yearbook in this field was stressed and the outline of a plan for its development was presented. The Board then invited Professor Brubacher to arrange for a conference with other interested persons in the field with the view of preparing recommendations pertaining to the content and organization of the volume as well as the personnel of the yearbook committee. The report of this group was presented to the Board and approved at the meeting held in Washington in May, 1940, and Professor Brubacher was requested to serve as chairman of the committee.

Dr. Freeman's report of the conference regarding the proposal for a yearbook treating different viewpoints in psychology was also discussed at the February meeting of the Board. Different opinions concerning the proposal had been expressed by different persons participating in the advisory conference, and the project was not recommended by the group as a whole. Professor McConnell, one of the

members of this advisory group, favored the proposal and presented an outline of a possible yearbook for the consideration of the Board. This plan was approved and Professor McConnell was invited to serve as chairman of the committee. The members of this committee were appointed at the May meeting of the Board.

The necessary appropriations for the work of these two committees were voted at different meetings of the Board of Directors as the requirements of the committees were ascertained. Additions to the original membership of the committees were made as work on the Yearbook progressed. Some difficulties were encountered in the effort of the committees to bring the two projects to completion in accordance with the desire of the Board to present companion treatises on these topics in the same yearbook. The work of the Committee on the Psychology of Learning is herewith presented as Part II of the Forty-First Yearbook. Part I, entitled *Philosophies of Education*, is presented in a separate volume.

NELSON B. HENRY

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INTRODUCTION

INTRODUCTION

THE PURPOSE AND SCOPE OF THE YEARBOOK

T. R. McConnell
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I. Purpose of the Yearbook

The purposes of this Yearbook are (1) to provide a concise and authoritative statement of three of the most active and influential theories of human learning; (2) to show that although there are differences among them, these systems possess many fundamental points of agreement which are often obscured by different terminologies, and that these common principles constitute a sound and positive basis upon which constructive educational thinking and practice can proceed; (3) to indicate that the theoretical positions are to a considerable degree complementary, each making a useful contribution to a comprehensive description of the learning process; and (4) to present in a manner primarily constructive and only incidentally controversial, a discussion of some of the more important phases and conditions of human learning which are particularly significant for education.

II. Theories of Human Learning

1. Theories Selected for Presentation

Section I of the Yearbook is composed of outlines of the three theories of learning—conditioning, connectionism, and field theory—and an examination into the degree to which these points of view may be reconciled. Although there are more than three broad systems which are worthy of consideration, it was obviously impossible to include all of them in the volume without condensing them into the barest skeletons. As it is, the summaries which have been included will probably seem all too compact and abstract to the psychological layman who would like to have many more concrete illustrations and applications. The reader who desires a more comprehensive survey of schools of psychology can find it in such valuable books as Heidbreder's *Seven*

Psychologies (6), Woodworth's *Contemporary Schools of Psychology* (15), or Keller's *The Definition of Psychology* (8).

Some persons may object to the particular choice of systems which the committee has made. They may believe, for example, that it would have been better to include the psychoanalytic view of learning than the conditioning theory. It seemed to the committee, however, that the three theories presented are the principal protagonists in the contemporary scene, and therefore it should be useful not only to outline them but also to inquire into the extent of their similarity.

Although the committee realized from the first that the Yearbook would have to be selective, it early faced a problem which made it necessary to restrict the number of topics in both sections of the volume even more than it had intended or desired. Any one of the general theories selected for inclusion, or any other which might have been chosen, for that matter, is not a rigid, final, or complete system. Rather, not only the details but even the basic principles may vary from one to another exponent of the same broad theoretical point of view. For example, psychologists who hold in general to the position that learning is a process of conditioning do not always agree on the interpretation of experimental data; in other words, they may develop somewhat different constructs for the purpose of relating and organizing empirical facts. Furthermore, some of their basic postulates or hypotheses, which are the more fundamental and general components of a system, may be differently conceived. Many illustrations of the variations within a general school can be found in the theoretical chapters of the Yearbook. Gates is so impressed with the differences within systems that he remarks, in his chapter on the Thorndike-Woodworth account of learning, that "there are so many varieties in every 'school' that some formulations of different 'schools' are more alike than the extremes within any one."

It is only natural for a theorist, when asked to write a brief statement of a systematic point of view for a yearbook such as this, to outline his own position. It becomes desirable, then, and in fact necessary if an authentic account of a broad systematic trend is to be provided, to include more than one representative of a general theory. In the case of conditioning, Guthrie submitted a chapter which did not purport to give a general survey of the theoretical literature on conditioning, but which summarized his own point of view. Since Guthrie's position differs in certain important respects from that of other psy-

chologists in the field of conditioning, the committee considered it desirable to have another outline of conditioning theory presented, and so invited Hull to summarize his conception of the learning process. In his chapter on the field theory of learning, Hartmann did not include an extensive treatment of the particular developments in that general 'school' for which Lewin and his students have been chiefly responsible. The committee, therefore, asked Lewin to prepare a statement which would represent his present view of the nature of learning.

An interesting situation arose in connection with the presentation of Thorndike's conception of the learning process, which is generally known as connectionism. The committee had hoped that Thorndike would summarize his own point of view for the Yearbook, but he found it necessary to decline the invitation to do so. The interpretation of connectionism which Sandiford then wrote at the committee's invitation, however, differed considerably from that held by other students of Thorndike. The committee deemed it essential to have these differences in interpretation delineated, and therefore requested Gates to prepare a brief statement of his understanding of Thorndike's position.

There is no intention to imply that Sandiford stands alone in his interpretation of Thorndike's extensive writing on the psychology of learning and the psychology of the school subjects. It is probable, in fact, if one may judge from much of the literature in educational psychology purportedly written in conformity with Thorndike's views, that Sandiford has formulated in systematic terms (which is difficult because Thorndike apparently has never been primarily interested in developing a system) the conceptions of bond psychology which many persons have acquired, either rightly or wrongly. Gates' explanation, however, has decidedly different systematic and educational implications from those inherent in Sandiford's exposition. The committee believes it is worth while to place these two statements side by side and to encourage the critical reader to make his own judgments concerning the differences in systematic interpretation and educational application between the two chapters.

2. Reasons for Presentation of Learning Theories

a. The Need for Restating Dominant Theories. A survey of the reasons why the committee decided to devote a substantial amount of space to theories of learning may be in order. First of all, such a pre-

sentation is timely, for the educational literature is full of condemnations of teaching methods, testing procedures, and curriculum practices which, we are told, are invalid because they are based upon an outmoded psychology. The charge that a given educational principle or practice is rooted in an 'atomistic' psychology seems to be the most serious indictment that could be made of it. On the other hand, the proponents of some different educational theory, curriculum organization, or teaching procedure often assume that they have demonstrated the merit of their proposals by identifying them with an 'organismic' psychology. "The new psychology tells us . . ." is a favorite clause for introducing educational effects which are presumed to follow from this school. We have been told, for example, that the effort to introduce unity into the curriculum, to assure integration in the child's personality, or to educate the whole person, is to be attributed to the teachings of some form of field theory. The association psychologies are often accused of fastening formal drill upon the school, and the configurational psychologies are acclaimed for having replaced memoriter exercises with creative experiences. The associationists have been censured for teaching that learning takes place through sheer repetition; the configurationists have been commended for showing that learning occurs as an act of insight which makes practice unnecessary.

But a careful reading of psychological systems reveals that their educational consequences or implications cannot be set off in such sharp antitheses. Although Hull disagrees with Guthrie on many theoretical points, he is willing to accept many of the latter's suggestions for the guidance of learning in actual educational situations. The pedagogical implications of Sandiford's treatment of connectionism would seem to clash with many of Hartmann's educational proposals, but Gates insists that connectionism as he interprets it can embrace most of the broad educational applications of field theory which Hartmann makes in his chapter.

Furthermore, both the honest critics and the sincere disciples of a man or of a system may misinterpret a point of view psychologically or misapply it educationally. It seems fair to judge that in the hands of many of its most enthusiastic advocates and users, connectionism has placed an excessive emphasis on analysis and specificity and seriously undervalued organization and generalization. Yet Gates, in his interpretation of the Thorndike-Woodworth psychology of learning, can find no justification for this 'perversion.' The critics who have insisted

that association psychologies are responsible for formal drill and the memorization of discrete items of information will discover in this volume that some associationists at least will not plead guilty to the charge. From the other side of the house have come accusations that configurational psychology is unscientific because it eschews analysis. But both Hartmann and Lewin point out that field theory emphasizes what they call functional analysis, and Gestalt psychology emphasizes the importance of differentiation of behavior, i.e., the emergence of details from a more general and unparticularized whole.

Although associationism has been charged with advocating little but tolerable repetition as the maid-of-all-work in learning, all the theoretical chapters in this Yearbook, as well as Stroud's discussion of the role of practice in learning, insist that practice must not be considered synonymous with sheer repetition. In spite of the popular notion to the contrary, Gestalt psychology and other variations of field theory have not eliminated the time dimension from the learning process. It still survives in such principles as repetition of the situation (rather than repetition of the response) which makes possible an interpretation of practice in terms of approximation and correction, i.e., progressive improvement in relation to some standard or goal of performance. Critics of field theory have insisted on interpreting insight as a sudden and all-or-none phenomenon (and have triumphantly pointed out that such behavior seldom occurs except in very simple situations), in spite of wide recognition in the Gestalt literature that insight often occurs gradually and partially, and may take the form of hindsight rather than foresight.

There is no need here to multiply these illustrations of misconceptions or misapplications of psychological theories. They are common enough in connection with all systems to indicate the need of making available, to persons in the field of education especially, an up-to-date statement of the essential principles of the systems which appear superficially to be in such irreconcilable conflict.

Debates among the systematists themselves, as well as the sharp distinctions which are often made in applying psychology to education or in rationalizing educational matters psychologically, have tended to exaggerate the differences among systems. It is not inherently undesirable, of course, to pay attention to important theoretical distinctions. Defining these issues may, in fact, stimulate research into fundamental problems of learning in the laboratory or in the school. But over-

emphasizing the differences serves to give the impression of utter confusion and perhaps of futility, and may suggest that there are no positive psychological principles upon which educational practice can be based. If there are substantial points of similarity among the dominant schools (and several attempts at synthesis indicate that such agreements really exist) or if the systems are to a considerable degree complementary, it should be possible to point out certain fundamental principles of learning which can be confidently accepted, for the time being at least, as the foundations of a sound educational program. To make these constructive agreements as emphatic as possible, the committee deliberately chose to stress the similarities among the theories of learning without any intention of implying that there are no differences, or that the distinctions which do exist are unimportant. It hoped to accomplish this synthesis, not only through chapter vii on *A Reconciliation of Learning Theories,* but through the chapters of Section II, which capitalize the agreements among the schools and supplement these bases with research on concrete learning problems.

b. The Need for Recognizing the Function of Theory in Scientific Development. The second reason for summarizing current theories of learning is that theory plays an essential role in the development of science. Professional workers in applied fields are sometimes impatient with theory in the basic sciences. They may prefer to investigate specific practical problems and give little attention to the conceptual relationship of the results. But the development of a science depends as much upon the continuous formulation and revision of theories as it does upon investigation and experimentation. It has been said recently, with respect to the conditions for productive research in education, that "theories properly understood and properly used are the most powerful tools at the disposal of science" (10). If this is true, it should be worth while to understand the nature and purpose of scientific theories.

Scientific theories are based upon facts or observations; they rest upon empirical data (3, p. 81; 5, p. 191ff). But the sheer collection and enumeration of data do not constitute science, much less scientific theory. It is not only important but almost inevitable that scientists will attempt to discover order in the empirical data by classifying facts and exploring and defining their relationships. Actually, the accumulation of a body of observations and the interpretation of these observations go hand in hand. Observations lead to ideas, and ideas, in turn, stimulate and direct further observation (7, p. 1). When the process

of organizing empirical data reaches the point where it relates specific observations through the development of general principles or where it interprets particular phenomena in terms of the operation of more fundamental, underlying factors, it has reached the stage of scientific theory (3, pp. 214-18).

The logical system of ideas which constitutes the structure of a scientific theory is composed of what are ordinarily called postulates or hypotheses. These postulates should be of such nature that known facts or observations are consistent with them. But their peculiar importance in scientific methodology lies in their use as means of *predicting* observations which have not yet been made or the results of experiments which have not yet been conducted. In other words, from the basic postulates of systematic theory, it should be possible to derive a body of specific operations which have not been, but ultimately can be, performed. The validity of a system of postulates is dependent upon the extent to which actual observation or experimentation verifies the predictions which have been logically derived from the hypotheses.

The most rigorous development of a theoretical system in psychology has been made by Hull in his *Mathematico-Deductive Theory of Rote Learning* (7). This formulation consists of (1) definitions of the essential terms employed; (2) a set of postulates or hypotheses; and (3) a body of interrelated theorems logically derived from the postulates and stated in such form that they can be empirically verified. Although Hull has elaborated this kind of system for only one rather narrow type of learning (the least significant, probably, of all types with which the school is concerned), he believes that it is only through the continuous development of rigorous scientific theory that our many psychological schools can be reconciled. He would let the psychological theorist begin with whatever hypotheses his observations of behavior lead him to postulate, insist that he make his deductions from these hypotheses rigorously, and then require that he determine whether they were consistent with facts already observed or were verifiable by further experiments. Hull believes that by checking the deductions empirically, the theoretical systems will be progressively revised, so that by a series of 'successive approximations' to an ultimate unified system, the theorists will come to much closer agreement than they now are.

Obviously, what Hull has done for rote learning could not now be done so completely for all forms of human learning. In some of these

areas, at least, there is not enough experimental evidence from concrete investigations with which to begin. But there is a significant value in psychological systems of the kind which we now have, tentative and incapable of accounting for complex learning processes though they may be. This value has been well stated by Heidbreder in the following passages:

> "Systems of psychology are to be regarded not as statements of scientific knowledge but as tools by which scientific knowledge is produced; not as accounts of scientific fact, but as means of acquiring scientific fact. . . . For scientific knowledge does not merely accumulate; it is far more likely to grow about hypotheses that put definite questions and which act as centers of organization in the quest for knowledge. . . . Frequently the victories of science are won through the use of conjectures that become the basis of active and ingenious research especially directed toward that particular body of evidence which will prove or disprove the point at issue" (6, pp. 12-15).

The fact that these systems often appear to be in conflict is not as serious as one might first think. Where there are fundamental agreements we can proceed to explore the educational implications logically and experimentally with the confidence that we are on sound ground. Where the systems clash, we can proceed to design and conduct crucial experiments which in many instances at least will throw light upon the theoretical issues and also upon the practical alternatives which grow out of them.

c. Learning Theory Is a Fertile Source of Educational Experiments. A third reason for outlining theories of learning is that they contain implications for education which are more and more frequently becoming the subjects of investigation and experimentation. Many such investigations have been made in the psychology and pedagogy of arithmetic. For a time, these studies were conducted for the purpose of applying bond psychology to the school subjects (11). More recently, experimental work in curriculum organization and in teaching-learning methods in arithmetic has been stimulated by interest in Gestalt theory (2). In several instances, experiments have been designed to compare the outcomes of instruction when arithmetic is organized and taught according to alternative theories or methods (1, 4, 9, 12, 14). One of the best illustrations of the way in which systematic psychology can be examined for educational implications

is the recent monograph which summarized the results and the theoretical interpretation of experiments in retroactive inhibition[1] and then proposed a series of specific investigations of instructional problems related to basic theoretical considerations (13).

III. Conditions of Human Learning

1. Importance of Research on Practical Learning Problems

In the attainment of scientific control over learning, investigations suggested by the development of systematic theory and those related to practical educational problems are both influential. Very often experiments conducted as a means of solving specific problems in learning to read, to spell, or to accomplish some particular school task, as well as investigations of child development in the fields of motor ability, language, social behavior, and emotional control, have important implications for learning theory, if the results are scrutinized for such meanings. A systematic examination of research in reading and language, for example, would reveal a great deal of evidence which bears on theoretical problems in learning.

When some of the principal aspects of the learning process, such as the influence of interest and motivation, the role of practice, the relationship of emotional behavior and learning, the development of meanings and ideas, and the improvement of problem-solving ability are studied, the need and value of research on practical problems in the guidance of learning become impressive. On some of these problems, the evidence from any source is still meager, and what exists has often been conducted in the psychological laboratory so that its validity for classroom guidance is unknown. In other instances, there is a considerable body of evidence secured in realistic learning situations from which educational principles can be derived with greater confidence. In his chapter on the development of meanings and ideas, which is probably the central problem in learning, Horn has pointed out that, while general psychology has contributed much in basic theory, and particularly in hypotheses to be tested in classroom learning, it has not produced much direct evidence on the problem of language and meaning. Most of the data which are available have come from the field of educational research.

[1] Retroactive inhibition refers to the interference of interpolated activity with the recall of material previously learned.

2. Presentation of Evidence on Selected Topics in Learning

In Section II of the Yearbook, the discussion proceeds from the summary of agreements among selected theories of learning to a survey of the available evidence on selected topics in the psychology of learning. Like Section I, the second part of the volume is not comprehensive. Other important topics could have been added, such as the acquisition of skill or the development of creative ability. But the ones which have been included certainly are among the most important forms and conditions of learning with which the school is concerned. The treatment, as suggested before, is only incidentally controversial. The authors have built, wherever possible, upon principles which are common to the theories of learning outlined in the first section, but in most instances have depended primarily upon experimental evidence for their material, with emphasis on that which has come from research with human subjects on educational problems.

The Yearbook will have been useful if it succeeds in stimulating an interest in the educational significance of learning theory and in encouraging more intensive research on practical learning problems in which pupils are the subjects and the school and the community are the laboratories. What we most need in educational psychology, probably, are carefully designed experiments with a double reference: to fundamental problems of learning theory, on the one hand, and to significant educational problems, on the other.

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SECTION I

THEORIES OF LEARNING

CHAPTER I

CONDITIONING: A THEORY OF LEARNING IN TERMS OF STIMULUS, RESPONSE, AND ASSOCIATION

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I. Introduction

I was talking with a boy whom I had never seen before, and a stray impulse to refresh my memory of what went on during a school day led me to ask him to give me an account of one. He answered with a certain friendly tolerance for the meaningless questions of grown-ups, and what he said is here reported word for word. I did not understand all of it.

"We have a man teacher. He doesn't get mad much. We talk a lot. If somebody throws a pen or stuff like that, he puts you out in the hall. We have 20 words for spelling. We write them on Monday and Wednesday and Friday, but it only counts on Wednesday and Friday. Then we have social science. It's really history, but he likes fancy names for things. Then we study geography and then mathematics—really arithmetic, you know. He gives us some fancy doo-jigs to work with. About two boys get their seats changed if they've been poking somebody. Then the teacher gives us exams and stuff and we have recess—ten minutes—not much time for doing things. We mostly play marbles. Then the bell rings and we go in and the teacher talks a lot about notices. Then the music class. The music teacher talks a lot. We don't sing much. Sometimes we sing a review song, but mostly the teacher talks. Then we have reading. The teacher is nuts about ancient literature. Then we check our books at the book table. They have about 200 books. Some of them are good and some are corny. We have shop, too; make things. There's a jig saw and a lathe and a sander and a printing press. We use all those things. I made a record case and a broom holder and a box."

Obviously a boy who has been through such a day is different from the boy who went to school that morning. And since learning means changes in behavior that are the result of experience, the difference in

the small boy should be describable in terms of learning and learning theory. His account of his day, of course, gives us no adequate notion of what he has learned. I realize that I might be led to a severe depression by hearing a similar account of one of my own lectures. The description of a day in the grade school was adjusted to the listener, and was just the boy's way of ridding himself of an unusual and embarrassing situation. He might merely have departed, or answered, "Aw, I don't know." That he did not, but replied so patiently and at such length, is evidence, we would all grant, of other past learning, of habits and attitudes formed in his home as well as at school. He was friendly and communicative, probably the result of his up-bringing.

Teachers are expected to take a hand in the learning that goes on in the classroom. They do this in terms of their own habits, habits they have formed as their adaptation to the schoolroom situation, and in terms of those schoolroom devices that they have seen or heard described or have hit upon by accident. A practical book on teaching methods is very different from an essay in psychology. It is more like a cookbook full of tried recipes but without much theory in organic chemistry. Cooking involves chemical reactions at every stage, but training in organic chemistry does not make good cooks. Training in psychology will not make good teachers; but there is no doubt that good teachers can be better for an acquaintance with the general psychology of learning as a means of correcting and guiding teaching practice, just as the chemistry of foods becomes necessary in the food industry where the health of many persons is at stake. It avoids costly waste and errors. A sound psychology furnishes the rationale of good teaching.

II. Stimulus-Response Psychology

A good psychology of learning must state the rules of learning and these rules must be understandable and verifiable. This means that they must deal with things that can be seen and heard and recorded. We reject explanations of learning in terms of 'synaptic resistances' or electrical fields in the brain, simply because there is no present way to observe these or to know whether laws stated in such terms hold or do not hold.

Nor is there any use for laws stated in terms of 'total situations,' for these are unique and have no names. Our rules must be stated in terms of observable and nameable conditions and consequences.

The present account is written chiefly in terms of stimulus and response because these are the two most observable features of the boy in process of learning. The inner events in his nervous system can be inferred from the results of brain injuries verified at autopsies, or from the results of experimental interference with the central nervous systems of animals in the laboratory. But it is still impossible to tell the difference between a boy who has acquired the right spelling of a given word from a boy who has not by examining their brains. We are demanding that our learning theory shall speak in terms of what can be observed to occur in the classroom. The 'field theories' of neural action offered by Gestalt psychology are supposed analogies to field theory in physics, but the former unfortunately lack both the clarifying equations of the latter and the observable terms that enter into these equations.

As we watch the boy in the schoolroom we discover the occasions for a good deal of his behavior. He answers questions (which have stimulated his ears) or responds to the movements of others, to their statements, to cold and heat, to his desk, to being poked from behind by a companion. We can see both the occasion for the response and much of the response itself. A naive observer is likely to miss completely another class of occasions for response. The boy is obviously not a mere passive recipient of sights and sounds. He is reacting to more stimuli than those imposed on him from without. He is reacting to himself. *What he is doing at any time is our best indicator of what he will be doing the next moment.* There are good physiological reasons for this. He has sense organs in his own muscles and joints that make him sensitive to his own movements, as well as sense organs on his exterior that make him sensitive to the behavior of others.

We do not share these inner stimuli that account for the larger part of the boy's behavior as we do the lights and sounds that affect his ears. But we can observe them nevertheless. We can see the postures and the movements that stimulate his inner sense organs in muscles and joints and we can predict a considerable portion of his behavior from what we see him doing.

If we are interested in predicting his behavior, the 'weather signs' for such prediction are thus stimuli and patterns of stimuli. There are also other bases for prediction. We know something about him and how he will act as soon as we recognize him as a human being, or as the child of his parents, or as from a certain social class, or as having

a certain mental age. But if we are interested in what he will learn and the circumstances under which he will learn it, we must turn to the observation of what he does (his responses) and the occasions for these responses (stimuli).

Responses, the answers to stimuli, are limited to the contraction of muscles or the secretion of glands. In practice, when we actually observe the boy and speak of his response to a stimulus situation, what we select is usually some outstanding detail of an infinitely complicated total response. We can discuss actual behavior only by choosing some nameable detail in which we happen to be interested. The rest we either take for granted or forget. It should always be kept in mind that there is this total response from which the recorded or observed feature is abstracted. The boy wrote a word correctly in a list. At the same time he did numerous other things in which we happen to be less interested. He may have put his tongue in his cheek, wrapped his right leg about the leg of the desk, muttered the letters as he wrote. Careful use of modern laboratory equipment would probably show that his lips are always busy forming the unvoiced letters in his spelling lesson, and that this disappears only as spelling is completely mastered and becomes a fixed habit. In this case the unvoiced word may suffice as the accompaniment of the writing.

The boy's response always includes another set of events that are not included in our name for what is done. Heartbeat and breathing, endocrine secretion, vasomotor changes are closely fitted to action. The general musculature is tense or relaxed, or certain portions are in a state of tonus and others are not. He is ready for some actions and not for others.

It is sometimes carelessly remarked that a person cannot do two things at once. This does not mean that he cannot whistle and walk at the same time, or listen to the radio and carve his initials in his desk, or answer his teacher and forward a note to his neighbor. We mean that between some activities and others there is interference.

This interference can take place on a very simple and physical level. We cannot turn the head to the right and left at the same time, or raise and lower an arm simultaneously. As a matter of fact, our muscles actually can work at these opposed ends at the same time, although the result will not be movement because muscles are working against each other. There are some instances in which interference goes deeper, so that if one movement is under way the muscular contractions

that would bring about the other are prevented from having the nerve impulses that would activate them. This type of prevention of one activity by another is called *inhibition* and is accomplished in the central nervous system. The boy may find that he can listen to the radio and study at the same time. He listens to the music by keeping time to it with some muscle group. In a modern high-school boy, it is likely to be a large number of muscle groups. But when the musical program stops and talking commences, he finds it impossible to read and remember. His eye may continue to follow the print on the page; but his vocal muscles (which are probably always active in effective reading) cannot respond to two different sets of words at the same time. Either the book will keep him from responding to the radio conversation, or the radio will keep him from effective reading, or he may fail to follow either source of stimuli effectively, because there is mutual inhibition.

Inhibition applies to emotional responses as well as to movements. The physiological changes that depress action or that reinforce action may replace each other or interfere with each other. There are three ways in which excitement may be produced. One of these is by intense stimulation of any sort. Watson was on the right track in his statement that there are just two instinctive stimuli for fear, namely, loud noises and falling; but in this statement Watson made two errors. The condition aroused is not necessarily fear, but may be only excitement; and there are not just two effective stimuli, but any sudden and intense stimulation will operate.

The second origin of excitement is through a series of stimuli which leave accumulated effects. One prod from the boy behind may not have at all the effect of the fifth prod. Each has left behind a slight increase in muscular tonus and general excitement and these have accumulated so that the response to the fifth prod is a howl of rage or vigorous reprisal.

The third method is through interference with action that is going on. A child is annoyed by interference or by obstacles in his way when he is occupied. His actions are reinforced and more vigorous. This interference may be between opposed lines of action in the boy himself. The conflict between tendencies to avoid the teacher's disapproval and tendencies to attract the attention of his neighbors makes this occupation exciting. The excitement we derive from gambling or from sport springs from the conflict into which these occupations put us. Without

the teacher's disapproval, many classroom activities would lose their 'kick.'

States of excitement play an important part in learning because they intensify action, and by intensifying action alter its results and bring new stimulation. Excitement is often the essential condition of adaptation and learning because it means vigorous action and new behavior.

What is here being suggested is that we attack the problem of classroom learning in terms of stimulus-response and the reinforcement of action. Such an attack has its difficulties. Our descriptions of the boy and his reactions to the situation in which he is placed will be only rough approximations of the real events. The situation in the classroom is a continuous stream of change. When we pick out some special event or feature for our attention, we violate in some degree the nature of the actuality. The boy's response is also a series of continuous changes, not divided into the nameable features to which our description is limited. Actions, like rising from his seat, answering a question, or making a mistake in a multiplication, we cannot do justice to. They occur in a total response that is infinitely complicated and merges into other responses. But total responses have no names and no description. To give up describing behavior because we cannot do justice to the complete event (as Gestalt theory would suggest), is to take an unnecessarily defeatist position.

In naming responses common sense uses words not for actual movements but for the effects of these movements. The boy sharpens his pencil, writes in his book, walks to the door, signals a companion. These are acts, not movements. Writing can be done in many ways, with either a hand or a foot, and still be called writing. We speak of writing on the typewriter, which is done by very different movements from those demanded by a pen. Common sense does this because we are usually concerned more with the results of a movement than with its style or detail.

But the boy's nerves connect his sense organs with his muscles, not with his notebook, the door, or his companion. The psychology of learning must therefore first apply to movements and not to accomplishments. The Gestalt theories and Tolman's purposivism are efforts to connect accomplishment and situation by psychological laws. Although such laws may be formulated, they have two limitations. They remain extremely tentative because they predict success; and failure is both unfortunately common and important. Secondly, they fail to

attempt to predict the movements by which results are accomplished; and this is the field of the teacher.

III. The Principle of Association

There is one feature of learning with which all men are familiar. "The burned child dreads the fire." "Once bitten, twice shy." The sight of rain reminds us of our umbrellas. The theatre ticket stub reminds us of the play that we attended a month ago. Mention of a friend's name recalls the intention to write or to visit. The name of a punishment has some of the deterring effect of the punishment itself. The teacher's annoyance with a pupil is revived whenever she looks at him. The examination question, if the proper experience has taken place, serves as a cue for the answer. We call this associative learning.

Common sense is a little vague, however, about what it is that is associated and what are the circumstances that establish an association. The rule of association is here stated in terms that, to some persons, appear to violate common sense. We propose it thus. *A stimulus pattern that is acting at the time of a response will, if it recurs, tend to produce that response.* This is here assumed to be the basic event in learning and will be referred to as the *principle of association.*

For many centuries psychologists have not been at all definite about the answer to the question: What is associated? Aristotle, Hobbes, Locke, and Alexander Bain (to take a few representative writers over a period of two thousand years) appear to have been vaguely aware that sights and sounds and other forms of sensation can arouse ideas, and that ideas can somehow arouse action and can certainly stimulate other ideas. But it is our desire to apply the principle to material that can be observed and material with which the principle can be verified. Our position is that what is associated is a stimulus and a response. It would perhaps be more exact to say that what is associated is some stimulation of sense organs and a corresponding muscular contraction or glandular secretion. By calling them associated, we mean that the stimulation has become the occasion for the response because of a past association of the two. Both stimulus and response are observable. Only by using observable and nameable items in our theory can we hope to illustrate it, apply it, or to verify it.

The Russian physiologist, Pavlov, assumed that the association was between two stimuli, the original stimulus already able to call out a

response and a new stimulus associated with the original stimulus and hence now able to call out a response. My reasons for rejecting this statement have been stated at length in my *Psychology of Learning.* It appears to me that the essential association is between stimulus and response. If the original stimulus occurs but fails to cause its usual response, there will be no association. There are other sharp divergencies between the views here presented and the views of Pavlov.

An important corollary of the principle of association as here stated is that *we learn only what we do.* Teachers have long been familiar with the phrase: Learn by doing. This is not the equivalent of the statement that we learn only what we do. Once a response has been elicited, once we do anything, the contribution of associative learning is to make it possible to elicit the response in new circumstances, because stimuli that were on the first occasion not contributory to the response have become its signal.

If we learn only what we have already done, how are we to produce any new behavior in a pupil? The answer is that, partly because the world never repeats itself exactly, new behavior is always being produced. New behavior is the result of new combinations of stimuli, and these produce compromise responses that are also new. All that the most sophisticated man can do in any situation is to contract his muscles in some order and pattern. Sophistication consists in having developed new orders and patterns and having these dependent on the proper signal. After the compromise has once been produced, it can on a second occasion be elicited by a general situation like the first, save that certain stimuli essential to its appearance on the first occasion can now be omitted, provided that certain others then present but not essential are now repeated. What the small boy originally did at the teacher's directions, he now does when the bell rings or when she nods to him. Learning is essentially a change of signals necessary for eliciting behavior. However the behavior was originally produced, it is now possible to omit some of the original determiners, provided we substitute cues that have been associated with the response.

In all the experiments on association and on conditioning, it is taken for granted but almost never mentioned that *the general situation must remain substantially the same.* Behavior learned in the classroom will not be in evidence on the street.

In its simplest form, teaching consists in inducing by one means or another some desired pattern of movement, whether of the whole

body, of hand and eye, or of speech. The movement must be induced in the presence of the stimuli that we wish to make its cues or signals. When that has been done, the signal is effective without the inducement.

If we wish to train a dog to come when its name is called, we induce it, by whatever arts are known to us, to come. If we cannot do this we cannot qualify as dog-trainers. As the dog starts to come, we call its name. The name is eventually effective without the blandishment that was at first necessary. It has become a signal for the movement. In some dog training this is very crudely evident. The dog is put on a long check line. As he walks or runs about, the trainer suddenly gives the whistle or call that he desires to make the signal for stopping 'dead,' and at the same time halts the dog suddenly with the check line. Eventually the dog learns to respond to the whistle by a sudden stop. Or the dog is so placed that it cannot leave a position except by jumping through the trainer's arms which are extended in a circle and held close to the ground. Someone calls the dog and the trainer says, "Jump." By many repetitions with the arms gradually held higher and higher, the dog comes to leap through the circle at the command even when it would be much more simple to walk under.

If we wish to teach a child to read a printed word or phrase, we choose one with which he is familiar and use our knowledge of children in general and of him in particular to induce him to look at the phrase *while uttering it.* The phrase becomes in that general situation (which consists of confronting the book, being in the classroom, being spoken to by the teacher) the signal for uttering the sounds that belong to it. Many nonreaders among children foil our efforts because they have established habits of looking away from the printed word to which we point. They do not establish the proper association between print and sound because the visual pattern is not seen while the word is being pronounced. Grace Fernald's method of compelling the child to trace the word with his crossed fingers compels his visual attention to the pattern of the word *while he is uttering it.* This is, of course, no case of primitive or original learning, but is dependent on skills already acquired, the ability to trace an observed line and the use of the word in speech. The principle of association is not limited in its application to Pavlov's 'unconditioned' stimuli, or to what he calls second-order or even to third-order conditioning. It applies to behavior of any degree of removal from original instinct, provided only that the behavior can be established by one means or another.

The child that is punished at eight in the evening because he did not return home at seven will learn as a result of the punishment; but what he will learn will be problematical. Unless he is as rational as the average adult and can establish a chain of associations through complicated speech cues while he is brooding over his punishment, one thing he will not learn is to return in the future at seven. *He learns what he does.* To achieve a habit of returning at seven it is necessary with the average child to forget the first unfortunate outcome, which is now past and has had its bad effect on habit, and to lay plans to insure that the next evening he will be reminded in time and perform the action as it is desired.

It is possible for many of us to assent to the rule that people learn to do what they have been caused to do in specified circumstances but at the same time fail to apply this rule or to see its consequences. If in the classroom the teacher could form a habit of saying to himself, "These children are learning to do in these circumstances whatever it is that they are now doing," the result would often be either extreme depression or renewed activity on his part.

IV. Associative Inhibition

I had interrupted my seventh-grade informant, who gave me the resumé of his school day, in the task of skinning a bird, a one-legged coot, which he and two friends were planning to stuff. The process of skinning and cleaning was going on when I interrupted with my question about learning in the classroom situation. All three boys were intensely interested in what they were doing, but very tentative in their manipulation. This activity, I was sure, would, like the classroom, leave them very different persons. Learning was taking place. Their responses to birds and to the paraphernalia of taxidermy were changing rapidly. In such changes we notice not only that new compromise behavior, based on the past, appears and that this behavior may be associated with new cues, but also that much behavior observable in past responses disappears. Signals lose their ability to call out responses. They may even acquire a distinct negative effect on responses that they formerly elicited.

This negative effect of learning, the detachment of responses from their cues, is obviously a corollary of the principle of association. When a cue is associated with a response that inhibits its old response, it

will obviously cease to call out the old. We may call the phenomenon *associative inhibition*. We lose fears by being led to act differently in the presence of the fearsome object, to laugh or to be occupied with other affairs. The phrase, "nine times six," ceases to suggest to the pupil 56, as it has in the past, if the teacher or some set of circumstances has led to the substitution of 54 for 56. The new association replaces the old. If we are caused to work in the presence of annoyances, these may even become necessary sustainers of our energy. If the sight of a bird's interior has established new responses and these have been in evidence while examining the exterior, the exterior comes to have new meaning and significance, that is, to suggest other behavior than the energetic attack and preparations for stuffing. Drinking castor oil in orange juice has radically changed many persons' responses to the latter.

Every instance of learning involves both positive and negative association. For every response attached to a cue, some former response has been detached.

Practical detachment of undesirable responses from their cues can be brought about in three effective ways. One of these is to present the cue along with stimuli for inhibitory responses. The dog that has pursued and eaten chickens has often been cured by tying the corpse of a chicken about its neck. The dog's response to an object tied to its neck is very different from the excited hunting that had been associated with chickens. All the dog's effort is to get rid of the incubus. In the future, avoidance replaces approach when chickens are seen at close quarters.

A second method consists in repeating the signal until the response is fatigued and in continuing it for some time. After fatigue has stopped the response, new behavior takes its place, and the signal is acquiring new associations. The book that we continue to read, after fatigue has stopped active response to its content, is making us capable of reading without following. A skilled dog-trainer of my acquaintance never gives a lesson over ten minutes in duration. She has found that continuing the lesson, after fatigue has diminished interest, has a strong negative effect on the retention of the trick being taught.

A third method is to introduce the stimulus which you wish to have disregarded, but only in such faint degree that it will not call out its response. Practice of this with gradually increasing intensity of the

stimulus brings about associative inhibition. The individual becomes habituated to doing something else in the presence of the stimulus.

It will be noticed that all three methods are psychologically the same method. Each is a device for presenting the stimulus and insuring that the undesired response will not be given.

There is a military maxim to the effect that one should never give an order that he does not expect to be obeyed. This deserves to be equally respected by the teacher. Because each time that an order is given and something other than obedience follows for any reason, associative inhibition tends to attach to the order. In many a classroom, tapping on the desk with a pencil has become a signal for disorder, because it has been always associated with disorder. The mother who pleads with her child for obedience has done this only in circumstances in which the child was reacting negatively. The only possible effect is that pleading will become a signal for negativism.

Nearly all arguments, by giving the opponent practice in defending the 'wrong' side, make us the signal for opposition. In many families and in many classrooms there are persons who arouse opposition even before they have been heard in full. The mere sight of them talking has become the signal for an attitude of contrariness.

V. Forgetting

During the summer months we grow 'rusty' in the mathematics that we studied in the spring. Even the week-end finds us on Monday with less information than we had on Friday. The poem that we learn for an occasion may fail us after several months have passed unless we have rehearsed it in the meantime. Our pupil 'forgets' to do his home work, forgets that he was to appear for a rehearsal of the glee club.

Associative inhibition was described as the failure of a response to a cue after that cue had been associated with another response. Forgetting is also a case of the failure of a response to a cue. But forgetting is generally attributed to the lapse of time, and not to active relearning in the interval.

The difference between forgetting and associative inhibition is really a difference in the attention of the observer and not a difference in the phenomena themselves. There is no conclusive evidence that the simple lapse of time causes anyone to forget anything. If our interest is in the inhibiting response that replaces the older response, we use the term

associative inhibition to describe the phenomenon. This is the case when we are actively trying to replace a bad habit with a good one. We substitute careful manicuring and an interest in the appearance of a child's nails for nail-biting. But if we depend on the lapse of time instead of active retraining, and are not particularly concerned with what response replaces the old but only with the fact that the cue has ceased to be effective for the response that we are observing, we describe the phenomenon as forgetting. Forgetting and associative inhibition are the same event.

Jenkins and Dallenbach found that when material was memorized and the next period spent in sleep (as nearly as could be managed), only one-half as much was forgotten as when the next period was spent in waking. Bedtime stories are frequently recalled by small children the next morning in the most astonishing detail; but this is not true of stories told them in the morning and followed by active conversation. The lapse of time is effective in producing forgetting only because it usually or often gives rise to new associations that replace the old and hence destroy the connection between cue and response.

The child who has left school at the end of the seventh grade will recall many of the details of his last year for the rest of his life. The child who has continued on in school has these associations of the schoolroom and school life overlaid by others, and by the time he is in college may be very vague about the names and events of his seventh-grade experience.

When we are somehow protected from established cues we are well aware that these may retain their connection with a response indefinitely. A university faculty member's wife recently visited Norway, the original home of her parents. She had not spoken Norwegian since the death of her grandmother when she was five and believed that she had forgotten the language. But during her stay in Norway she astonished herself by joining in the conversation. The language and atmosphere of her childhood revived words and phrases she could not remember in her American home. But her conversation caused much amusement among her relatives because she was speaking with a facile Norwegian 'baby talk.' If her family in America had continued to use Norwegian, this 'baby talk' would have been forgotten, its associations with the language destroyed by other phrases.

Forgetting is not a passive fading of stimulus-response associations

contingent upon the lapse of time, but requires active unlearning, which consists in learning to do something else under the circumstances.

VI. The Effects of Repetition

Drill has been used in the classroom ever since there were schools. In most experiments on association or conditioning, repeated pairings of cue and response are found to increase the certainty and the energy of response and to decrease the latency of response. In learning a poem or a series of nonsense syllables, added repetitions even beyond the point necessary for one perfect reproduction still have their effect in better retention.

For these reasons many writers have made the 'law of frequency' a statement of a fundamental property of association. Thorndike has offered evidence against this and I believe that he is quite correct in deciding that the law of frequency can be no longer retained as a general law of learning. The effects of practice do not depend on mere repetition, but on the conditions of repetition, and these conditions vary enormously in different learning situations. In both human and animal behavior, associations established on a single occasion are the rule rather than the exception.

Pavlov used from ten to fifty pairings of a signal and food to establish most of his conditioned salivary responses in dogs. Many modern experiments find several hundred pairings necessary in associating such a response as jerking the hand away from a charged plate with the sound of a buzzer. But the practice of psychologists does not indicate that they take very seriously the notion that associations depend on repetition. Papers read before the American Psychological Association are normally read only once, and there is often evidence that associations have been established in some of the members present. Even if the Association, instead of having two hundred papers read at its annual convention, selected the best paper and had it read two hundred times, we should not expect great improvement in the memory of the attendants for its contents.

The facts are probably better described by the assumption that *a stimulus pattern gains its full associative strength on the occasion of its first pairing with a response.* Although we are familiar with numberless instances of this, the statement appears to contradict many known facts of experiment and many experiences, to run strongly

counter to common sense. It remains true that we expect memories to be established by one experience, at least many of their associations. We have arrived at one of those many points in any science where the theorist is confronted with a choice. The facts appear confusing and contradictory. Our answer is to make our assumption of 'one-trial association' and to attempt to reconcile the apparent exceptions to this. This proves to be much more easy than one would have thought.

In order to use a very simple case we may leave the schoolroom and examine some results with animal experiments. Pavlov reports that it was necessary to repeat pairings of new stimulus and old stimulus between ten and fifty times in order to be fairly certain that the association was established. He also reported that when he had been given funds for an improved laboratory and was able to build soundproof rooms and place the experimenter in an adjoining room where the dog could not see or hear him, then ten or twenty pairings were sufficient instead of fifty or more. Here we have some hint of the explanation of the effects of repetition.

In the Pavlovian experiment the so-called unconditioned stimulus, the stimulus used to insure the appearance of the response, was usually food, presented when the dog was hungry. He chose this 'unconditioned' stimulus for its effectiveness in eliciting eating and salivary secretion against distraction. Food to a hungry dog will prove effective in interrupting nearly any activity the dog is engaged in. Rexroad has referred to such stimuli as "dominant." They are stimuli that experience has shown to be effective in a variety of situations and actions of the animal.

But on the occasion of the first association the food is actually effective in only one such situation. It interrupts only one action or posture of the dog. If the next presentation of the signal finds the dog engaged in the same activity as before, the new cue will be effective after only one trial.

But the chances of catching the dog in the same action or posture are remote. The second presentation of the cue may find the dog engaged in something very different. The cue has never been associated with the interruption of this activity. The new activity itself has never been associated with salivary secretion. The effect of the new activity is opposed to whatever associative effect the conditioner has acquired in its one association.

By the time Pavlov has carried through fifty pairings, the unconditioned stimulus, the food, has interrupted most of the repertoire of activities that the dog has in the experimental situation, and these as well as the signal have become conditioners. The chance that a new presentation of the cue will be aided by the dog's current activity instead of impeded by it has increased enormously.

It is very significant that Pavlov was able to reduce the number of pairings necessary by taking his precautions to limit the variety of the dog's activities in the stand, by using a soundproof room, by excluding the experimenter from the room, by giving the dog preliminary experience in the apparatus in order that it should struggle less during the experiment. *It appears that practice is necessary to the extent that the response must be elicitable from a variety of situations.* Thus, as practice is continued, the dog acquires many conditioned responses, and a new application of the signal will be the proper component of these practiced associations. The food will have forced the response in most of these possible situations and thus the chance that the next signal will accompany behavior that has been followed by the response is very large. It is, of course, never certainty.

This has plenty of applications to the classroom, when we are concerned with rote learning. Its application to the learning of skills and meaningful material will be considered later. When our schoolboy follows the text of a song with the class, numerous associations are established. One word furnishes signals for the next, signals given by the stimuli caused by singing the word itself. Some tendency is therefore established for the first word to lead to the rest and the singing of the song.

But we find that any radical change in the boy's position brings failure to remember. If he practiced in his seat and is now standing, his memory will be impaired. If he is asked to stand before the others and sing the song through, the chances of failure approach certainty. He has not been practiced in these situations. A rule of teaching appears: *Effective practice is conducted in the general situation in which we desire the future performance to be given.* If we desire the boy to be able to perform in a variety of situations, he must practice in a variety of situations.

There are numerous variations in our application of this rule. A supervised study period may prove effective in promoting attention to books or problems. We find that these habits do not carry over to

situations in which there is no supervision. The boy was dependent on the supervision for his behavior. The change from grade-school situation to high-school situation is a radical one. The effect is often to put the pupil at a loss. His habits of work do not carry over. Many wise grade-school principals provide for this change by introducing what they can of the high-school situation in the eighth grade, increasing pupils' freedom and responsibility.

High-school teachers of home economics have described to me many experiences which illustrate the same point. Their pupils learn to operate the modern equipment of the home-economics laboratory and to conform to the standards of neatness set by the instructor, who has used her skill to lead them into these ways and to safeguard the newly formed habits of cleanliness, etc. But a chance visit to the home of the pupil one year later may find almost no evidence of the training. The home kitchen, the family environment, failed to provide the cues for the behavior established in the school. To insure this carry-over it would have been necessary for the teacher to carry on some of her teaching in the home, or to have set up at school a sample old-fashioned and inadequate kitchen and perhaps a cross and hostile mother and to see to it that the new ways were carried through under these handicaps.

The assumption of one-trial conditioning, requiring such an explanation or justification as has been described, brings out a certain weakness in the use of the association theory, as I am well aware. I had some hesitation in discussing this in a paper addressed to skilled teachers rather than to specialists in the theory of learning. But the argument would not be complete without facing this weakness in theory.

Mr. Fred Sheffield, a former student, has recently asked me a number of difficult questions. One of them is this: How can we tell how much of the original situation must be repeated in order for conditioning or association to appear? I do not know any way in which this question can be answered in terms of general theory. The principle of association does not give the answer. That principle amounts to a convention that we shall use associated stimuli for the prediction of responses. It has no provision for measuring the relative effectiveness of different signals or the extent of similarity required in the practice and in the test situations. We can only answer the question after we have had experience with the general type of situation used and with the type of conditioner used. The principle of gravitation does not have this disadvantage. It states that two bodies in space will approach each other

with an acceleration equal to a constant times the product of their masses divided by the square of their distance. It directs us to predict what the bodies will do on the basis of distance and mass, just as the principle of association directs us to use the stimuli previously associated with a response if we wish to predict the response. But the terms of the principle of gravitation represent measurable quantities for which there are conventional methods of determination. The principle of association is not supplemented with any a priori method of determining in advance whether a substitute cue will act as an integrated pattern. The capacity for such integration in the nervous system has not been systematically explored. We can test the general effectiveness of a given stimulus pattern in the general type of situation used in an experiment, but such information is hard to generalize. There is some evidence for believing that the substitute signal must be one that would be responded to in its own right in order to serve as a conditioner.

Nor is the principle supplemented with any criterion for establishing the extent of the similarity of two general situations prevailing during practice and the later test for conditioning. If, for instance, Pavlov had given one pairing of a new signal and unconditioned stimulus in one general situation and then presented the new signal in a different room or with observers present, there would probably have been no conditioned response. He himself has mentioned that his conditioned responses could not be demonstrated before a lecture class, no matter how well established in the experimental room.

The teacher will have to continue to depend on his experience in order to determine when he can expect a 'carry-over' from one situation to another. Only experience with other pupils can assure him that his pupil will be able to perform under test conditions or before an audience or in the home environment.

In careful recording it is possible often to find traces of the associative response though the change of situation has prevented this from becoming overt. Inhibition is seldom so complete that there are not traces of action currents in the muscles that would be involved in the conditioned movement.

The effects of repetition, which Pavlov and many American psychologists take to be basic features of association, prove to be dependent on many features of the situation. Instead of acquiring a simple association by degrees as repetition proceeded, Pavlov's dogs

were doing a great deal of learning and unlearning in the conditioning series.

The acceptance of Pavlov's generalizations from his extremely specialized experiment as the basis for a general theory of conditioning has led many American writers into serious difficulties and has retarded the analysis of the phenomenon of association. It is quite possible that learning theory would be farther advanced if Pavlov's work had remained unknown in this country until psychologists were ready for it. This is not the fault of Pavlov, but of his slavish followers who have been too ready to generalize his pioneer discoveries into laws of learning. His insistence on high certainty of response, his use of a signal acting over a long period, his recording of only a small detail of the behavior, all served to represent conditioning as very different from ordinary learning, in which stimuli are fleeting, transient and complex and in which responses are subject to compromise with the behavior going on. Yacorzynski and I found that in conditioning an arm movement to a buzzer (the subject was instructed to move his arm when he felt a shock in the other arm), the highest certainty of response was found at the beginning of practice, before repetition, and that this certainty diminished through the experiment.

VII. Acquiring Skills

My seventh-grade informant is obviously acquiring many skills in the course of his schooling. Some of these are skills intended by the planners of the school system and some of them are not. Avoiding unfavorable notice from the teacher undoubtedly ranks high among them. Spelling is so clearly an aggregate of special associations that we are doubtful about classifying it as a skill. This probably holds also for geography and for social science (which was really history) and what he carried away from these was probably many rather detached bits of 'information' without many cross-references. His arithmetic is an undoubted skill that requires the integration of many habits. The music class in which "the teacher talks a lot" is contributing to the ability to sit patiently through hours of lecture without hope or interest when he reaches the university, an ability not usually rated as a skill because the end result of a skill must be something that we approve or that we can appreciate as 'good for something.' The record-case and broom-holder must have represented some advance in skill with tools, and the

books (some of them good and some of them "corny") may have helped to develop better habits of reading, along with the ability to withstand distraction and to tolerate being alone and absorbed in something besides the radio and the conversation of playmates. Many experienced children's librarians hold that the chief qualification for children's books is that they hold the interest of the reader; whether or not we approve their content or their style is less important. Reading habits established by any means carry over to new and better material as tastes become adult.

In the psychology of learning we often confuse the effects of repetition on a single association of stimulus and response with the effects of practice on the development of skill, which is something quite different. In learning any skill, what must be acquired is not an association or any series of associations, but many thousands of associations that will connect specific movements with specific situations. One lesson or one trial is all that is necessary to learn to depress the brake pedal on a car. Learning to drive the car requires a varied experience which will cause the pedal to be depressed in many situations and left severely alone in many others.

A first lucky drive to the green, a first arrow on the target, or the first strike at bowling does not make a man a golfer, an archer, or a bowler. The fortunate outcome was an accident. But it is out of accidents that skills are made. The next try is likely to be from a different stance and to have less fortunate results. The very fact that it is a second try rather than the first means that the action has a different beginning. In order to master the sport, the beginner must be exposed to the variety of situations that are encountered in the course of play. His awkward and erroneous movements must be somehow eliminated. His instructor's words or his own recognition of failure may lead to changes of attack with the result that new movements are attached to the situation. The problem of teaching skills is largely the problem of breaking up wrong action and encouraging practice in which there is eventually a chance of successful movement. The track coach or the orchestra leader may correct many obviously wrong methods by interrupting the activities and suggesting new behavior to replace the wrong methods. His method is to interrupt in order to discourage wrong movements and to leave undisturbed the right movements when they finally appear. *They will remain unless something happens to cause other behavior to be established in their place.*

The conditions of interest and motivation that contribute to the formation of skills will have to be deferred until after some discussion of motives. When I interrupted my seventh-grade acquaintance, he was engaged in preparing a water fowl for stuffing. This was an interest I did not in the least share, but in him this interest was able to overcome very definite tendencies to avoidance caused by the sight of the bird's 'innards.' It was probably an interest of higher intensity than the majority of those he found in school, where the main interest probably lay in avoiding unfavorable notice by the teacher.

VIII. Habit

Most languages have a word for 'habit.' We have always known that men have their individual ways; that these depend on experience has been common knowledge also. Our small boy was familiar with some of his teacher's habits and had adjusted himself to them. But little can be determined of the nature of habits from common sense, save that they depend on frequent repetition. For psychological use, the word must be given a definition that violates some of the commoner meanings of the word. We shall mean by 'habit' a pattern of movements, relatively stereotyped, that can be elicited by a limited class of associative stimuli in a wide variety of situations.

This meaning makes of such expressions as the 'drug habit,' the 'reading habit,' 'habitual generosity,' not true habits, but families of habits defined with reference to some particular end-result. In this sense, addiction to smoking is made up of thousands of habits. These are united only by the fact that they tend to eventuate in smoking.

An analysis of habit in terms of association must depend upon the notion of *movement-produced stimuli*. By this is meant stimuli for which movements are directly responsible. When a pupil turns his head, the movement changes the pattern of stimulation in his neck muscles and also changes the pattern on his retina. He now sees the teacher instead of the window, or the board instead of his neighbor. Every response that he makes, however passive, is probably the occasion for new stimuli to sense organs.

Behavior is thus its own chief guide. What a man is doing is normally the chief determiner of what he will do next, because what he is doing furnishes the bulk of the stimuli that will affect his muscles.

Any sequence of movements, however caused and directed, thus

furnishes stimuli for association with the succeeding response and, provided the general situation does not offer anything new and compelling, there will be a tendency for the resultant serial response to fix itself by internal associations between one movement and the next. The stimulation from each stage is contiguous to the movement of the next. We are particularly aware of such serial habits when they accomplish nothing or are annoying and embarrassing. In any schoolroom can be discovered tics or grimaces, or habitual gestures now meaningless, that are machinelike in their repetitiousness but which have no bearing on the present situation. They have been started 'by accident' or in a context into which they fitted. They are now 'mere' habits. Every teacher has mannerisms that do not contribute to teaching and are retained only because, when the movement is begun through some associative cue, the movement sustains itself through its internal associations.

One repetition is capable of fixing an elaborate series of movements that was originally guided by accident but has now become self-directing. By the time this article appears in print, George P. Horton and I shall probably have published an extended study of this repetitiousness of behavior based on the observation of about a thousand escapes of cats from a new type of puzzle-box.

That some account of these cats should be inflicted on readers whose chief interest is in the education of human beings, needs no excuse, in our opinion, because only the difficulty of controlling our subjects to the same extent keeps us from demonstrating the same essential behavior in human beings. I am confident that with proper funds for equipment any grade-school classroom could be made the instrument of an equivalent study. And the teacher who reads this account of cats will undoubtedly see that the underlying explanations apply as well to pupils as to cats. The general nature of learning is the same in animals and in man. It is only when we enter the field of rational learning and the use of speech that we find radical differences, and it will be contended later in this paper that these are not differences in the nature of the learning process, but differences in the nature of what is learned.

With the reader's permission, therefore, an account of the behavior of cats in a puzzle-box is here offered, with the hope that he will begin to see himself and others in a multitude of puzzle-box situations, behaving like these cats.

Our box had a glass front through which the cat could be photographed by an automatic mechanism set off by the beginning of the opening of the escape door. This was in the center of the large glass front. The cats were placed in a dark box in the rear of the apparatus and when everything was ready a pull on a lanyard opened an entrance door to the puzzle-box and started an electric clock. In the box itself was a post on a hemispherical base. Any slight movement of this post in any direction opened the escape door.

Most cats, admitted to the box from the dark chamber, were restless, especially if hungry, and walked about. They spent most of their time at the boundaries of the box (as Lewin would point out) and particularly at any outstanding features of this boundary, the doors, the cracks between floor and wall (figure-ground behavior). The cat would claw, bite, push, explore; and when this had gone on for some time, it would pause and groom itself or lie down.

Eventually most cats caused the pole to tilt by one means or another, biting, clawing, nosing the pole, or by 'inadvertently' (i.e., without looking at the pole) brushing against the pole, backing into it, falling on it, rolling on it while lying down.

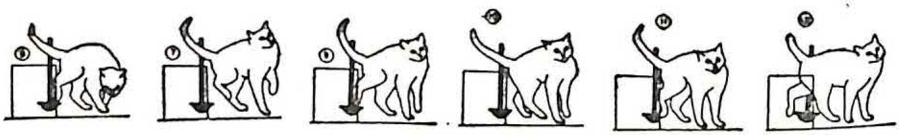
In a large number of cases this series of movements was repeated in great detail on the next occasion: not only the final movement that released the door, but the movements of entering the box, turning to the right (for instance), approaching the door, clawing, walking around the box, approaching the door again, and finally backing into the pole; all these movements might be repeated in the same order.

A rather detailed description of the behavior of one of the cats is here offered, together with some drawings of the cat at the moment of release. The drawings were traced from the negatives of the picture which was automatically taken as the door started to open. This particular cat, cat K, was notable for the variety of its movement-series within the box; but there is evident in this variety the repetitiousness to which we wish to call attention. There were other cats that persisted throughout ten to forty trials in repeating the same movements in the same order each time they were admitted to the box.

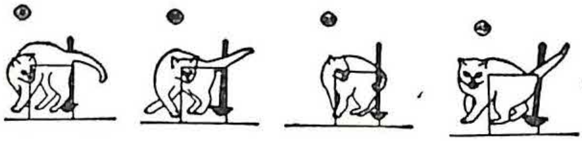
On March 18th, 1937, cat K (being hungry) was placed in the starting box and allowed to escape by an open exit door. This was done three times in order to establish a habit of leaving by the door. The door was then closed and the cat admitted to the box. On its first trial it struck the pole 'accidentally' while turning in the box only four

seconds after its admission. The same series of movements was repeated in the next two trials. The pictures of these three trials are below:

In the 4th trial the movement was repeated but the escape mechanism failed to operate and the cat walked around the pole, striking the pole with its right shoulder. This movement-series does not appear again. On trial 5 a turning movement substantially like that in the first 4 trials failed to operate the mechanism and the cat kept on turning, striking the pole with its rear foot and tail. This same movement-series was repeated in trials 6, 7, 9, 10, 11, and 12. The pictures below indicate that the photographic 'cross-section' of the series is substantially the same in all these trials. It should be remembered that the photograph shows only this 'cross-section' and that *the whole series of movements from entrance to exit was repeated.*



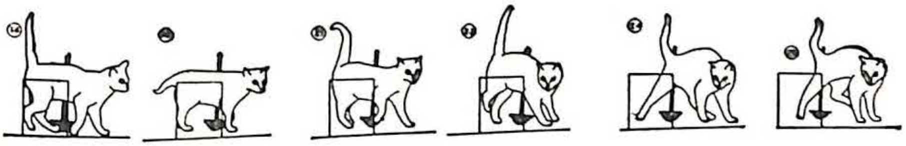
In trial 8 the cat turned around in the starting box and backed into the puzzle-box. This led to a quite new and different series of movements. The same happened in trials 16, 26, and 45, which give very similar pictures.



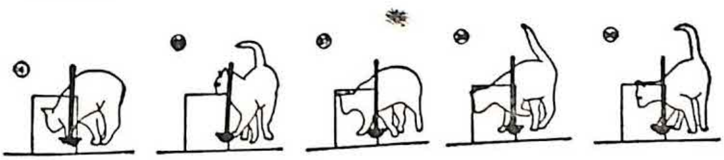
In trial 13 (the camera failed to operate for 13, 15, 31, and 32) the cat struck the pole with its left side while executing a turning movement rather similar to that in trials 6 - 12. This was repeated in trials 14, 15, 17, 18, 19, 21, 23, 24, and 28.

Two days later, trial 21 duplicates 19. In trial 22 the cat entered the box on the wrong side of the pole and repeated its 'leaning' move-

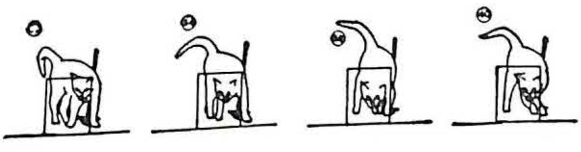
ment, but away from the pole. It finally went forward and struck the pole with its rear. This was repeated in trial 23, several futile side movements occurring. The cat then retreated, entered correctly, re-



peated the side movement (as in 14, 15, 17, 18, etc.) that operated the release. Trial 24 saw the same series of false entrance, futile movement, retreat, success. Trial 25 also, but release was caused by striking the pole with the left shoulder. Trial 26 is a duplicate of 8 and 16. Trial 30 repeats the movements of 4, 25, 27, and 29.



For the remainder of the trials the movement is the same as 14, 15, 17, 18, etc. (leaning slightly to the left while passing the pole). These movements show a slight but progressive change as may be noted from these four samples of these trials.



The one exception to these last 20 trials is number 45. In this case the cat backed out of the box and repeated the movements of 8, 16, and 26. The last ten of these trials appear in our film, "Cats in a Puzzle-Box." A complete record of cat K's escapes from the puzzle-box is shown on page 42.

The animal's first series of movements in the box has been referred to by some writers as 'random.' This word has been much misunderstood. The behavior is random only in the sense that it is not yet adapted to escape. In the box for the first time the cat does what cats

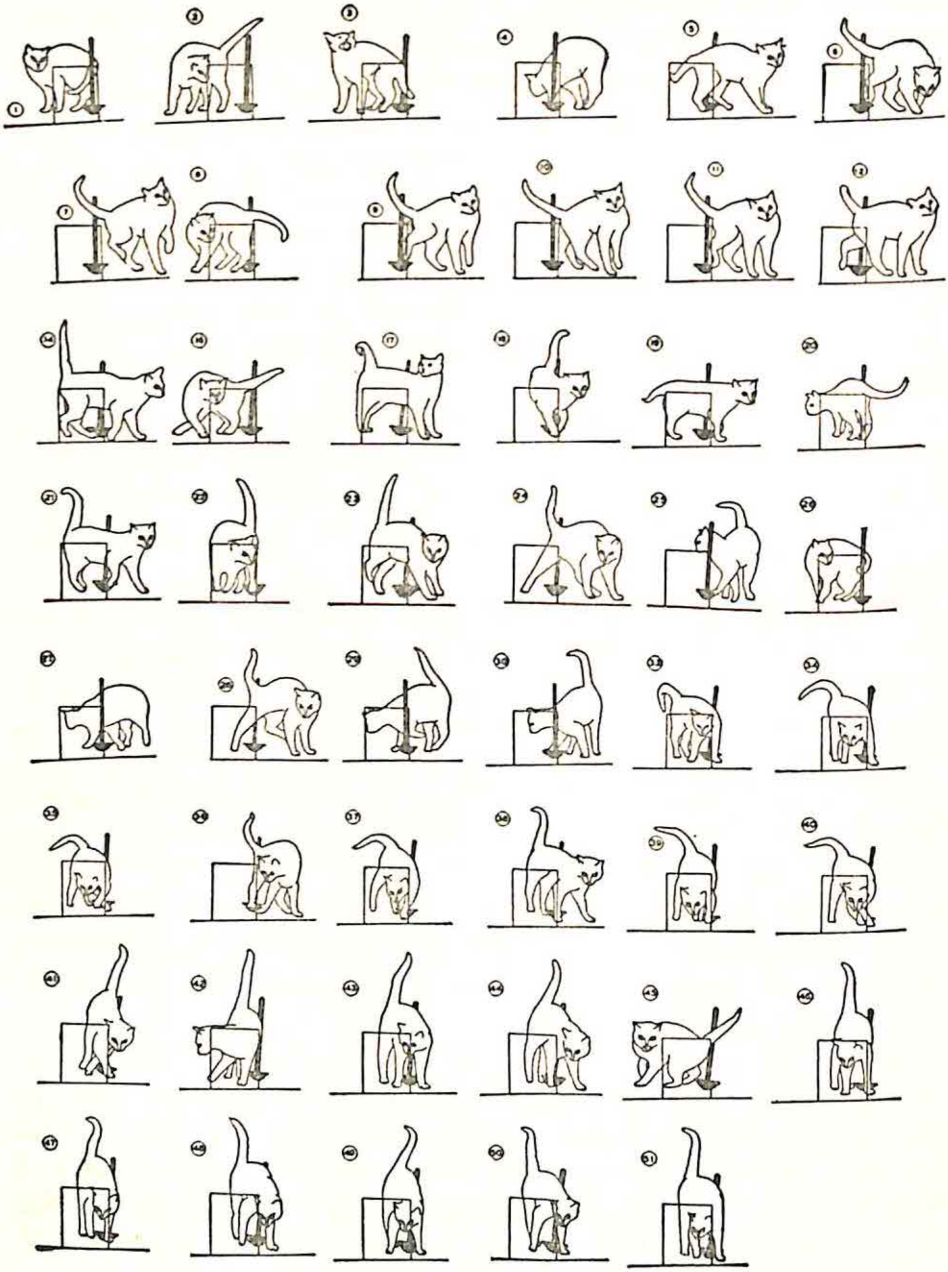


FIG. 1.—Complete record of the escapes of cat K from the puzzle-box. Tracing from projected negative. Picture taken automatically as post is moved by the cat. On four trials the camera did not operate.

naturally do in such situations or what its past training would lead it to do. Eventually some *movement* opens the door and the cat escapes.

When we tried to generalize the description of puzzle-box behavior, Horton and I were in fair agreement on the following rules:

(1) On being placed in the box the cat behaves as other cats have behaved with variations attributable to its own past learning. Household pets and cage-bred animals, for instance, behave differently.

(2) On a second admission to the box, the most probable behavior is a repetition of the last series of movements from entrance to exit. Such a full repetition seldom happens, but it remains the most probable behavior.

(3) There are fewer exceptions to this rule when the elapsed time in the box is short than when it is long. We attribute this to relearning *in the situation,* for which there is more opportunity in a long session.

(4) The most predictable movement is the final series that leads to escape.

(5) *The cat learns to escape from the puzzle-box in one trial provided that it escapes.* What it has once done can be repeated, provided the situation that confronts it the next time is unchanged in essentials. Numbers of cats repeated the method of their first escape for many trials.

(6) Improvement, the elimination of *some* useless movements and the reduction of time, comes with practice and is dependent on 'unlearning' or the learning of new responses to old cues. *Improvement cannot be formulated as a principle of learning because it does not always occur;* it is dependent on accident and circumstance. It is true that nearly all the cats were, on later trials, expending less energy and time in their escape.

Improvement could in many cases be followed in detail. A cat that had spent much time and motion in the box and eventually turned to the post and pawed it while looking at it would, on the next occasion, respond to it in this way earlier in the session. Its early responses to the post had been limited to avoiding it when moving about. At the end of the series it had responded differently, and this new response of approach took the place of the early avoidance.

(7) The cats had, in general, learned movement habits rather than a skill. When the position of the post was changed, the movement of escape usually occurred as before but was ineffective. For the new

position the cat learns *de novo* and its final escape movements may resemble not at all the previous ones.

This is reminiscent of the algebra students being taught by the writer many years ago. They had come from classes that had advanced through quadratic equations, but in their drill had always used x and y for the unknowns. When the new teacher confronted them with an equation like:

$$t^2 + 2t + 1 = 0$$

they were helpless, and complained that they had never had "t."

(8) When escape had been by 'advertent' response to the post, i.e., by pawing at or biting the post while looking at it, there was in some instances a transfer of training to the extent that the post in its new position elicited attention and was responded to, although not by identical movements. This served to eliminate long preliminary exploration. By placing the post in numerous different positions in the box we could have taught the cat a skill, that is, a repertoire of specific movements adjusted to the specific differences encountered in the situation.

In our opinion this puzzle-box learning is strictly comparable to the learning of human beings. There must be first some situation that produces activity, some maintained source of restlessness and uneasy behavior. In the ensuing activity some action eventually removes this maintaining stimulus for excitement. *This action remains associated with the distressing situation because, once the distressing situation is removed, it can acquire no new associations.* We thus tend strongly to learn actions that remove us from trouble and distress. The stimuli may be within us, as in the case of hunger. The act of eating does away with our restlessness and sometimes with its source. Eating becomes our cure for that particular form of distress.

It is possible to explain in this fashion how various odd appetites which serve to remedy vitamin or other deficiencies in the diet might be acquired. All that need be assumed is that they produce distress and restlessness. The behavior that finally ends this condition remains associated with the condition of deficiency.

Obviously, my seventh-grade friend, when he is in school, is in many puzzle-boxes at once. If his first escape from recitation has been accomplished by saying "I don't know," there is a strong probability that this will remain his solution until devices are used to make it unsuc-

cessful and to leave him under stress until he has done something else. If he can be guided under mild provocation actually to attack an arithmetic problem and kept 'exploring the cage' until he hits upon a correct solution, he is fortunate indeed. Attack on the problem itself will tend to become his only means of escape from scholastic pressure.

One of my colleagues, William R. Wilson, wrote for a local occasion a paper entitled "Pseudo-feeblemindedness in Students." The thesis of the paper was that an air of innocence and assumed stupidity was a student adjustment to the prevailing methods of college teaching, the lecture and assigned reading in quantity. It has been hit upon as an escape from the otherwise unendurable and distressing experience of sitting before a lecturer who is 'giving a lecture' rather than talking to persons in terms that they can understand or on topics in which they are interested. The material may have only a certain false importance because it will later be called for in an examination.

IX. Motivation

We are entering the field of motivation when we raise the question, "Whence arises the activity of the cat in the puzzle-box or of the pupil in the classroom?" Psychologists and writers in the field of education are fond of obscure verbal explanations and of the use of demonological agents in explaining the sources of human activity. The Freudian characters, the *censor,* the *id,* the *ego,* the *super-ego,* and the bickerings and quarrels of these agents are well known. Recent academic textbooks have tried to be more scientific by attributing behavior to drives and motives which are less obviously used as agents. But even the recent phrase so common in elementary psychologies, 'tissue needs,' offends in this respect almost as much as the Freudian *ego* and *id.* If needs explained or caused their own satisfaction, the world would be a place very different from what it is. In the strict sense, only organisms have needs and only persons have intentions and purposes. We may carelessly speak of an appendix that *needs* removing, but should not mistake this for more than a turn of speech.

We have assumed here, it will be remembered, that the normal occasion for muscular contraction, and thus for all behavior in the schoolroom or elsewhere, is the stimulation of sense organs. Skinner prefers the assumption that some behavior is 'emitted' by the organism to the alternative assumption that for some behavior the stimuli are obscure.

Our preference is for the latter statement. Men and animals are demonstrably equipped with a rich supply of sense organs in viscera and muscles as well as on the body surface. These sense organs demonstrably respond to muscular contraction and changes in posture, to behavior. Observed posture and movement are as good evidence for the stimulation of proprioceptors as we could find for the stimulation of the eye. In neither case can we record the actual stimulus. Recording the light that would affect the eye prevents that particular beam from acting as a stimulus, as was mentioned before. In either case we infer the fact of stimulation rather than observe it.

If stimuli are accepted as the determiners of the pattern of movement and the galaxy of somatic mechanisms that supports action, i.e., if endocrine secretion, glycogen control, elimination of fatigue products, blood pressure, metabolism, etc., are accepted as accounting for the energy of movement, why are these not sufficient for the explanation of motives?

The answer has been, of course, that an animal may be twice in what is apparently the same situation and respond very differently. Pavlov's dogs behaved very differently when hungry and when fed. Men and animals appear to be 'driven' and the drive appears to be directed very definitely in the path toward a definite goal. What the hungry dog wants is food. What the hungry scholar wants is food. At other times he wants to play, to tease a friend, to please the teacher, to escape from the schoolroom. Some of these wants appear to be phylogenetically determined. Others of them seem to be established through individual experience.

The position here taken is that such driven behavior originates either in stimuli or in general physiological states which have as their most important characteristic the evocation of excitement with consequent low thresholds for activity. The direction of the 'drive' toward a goal is determined by the fact that the maintaining stimulus or physiological state is abolished by definite types of movement. Eating relieves hunger, scratching relieves an itch or a tickle, exercise or added clothing or the neighborhood of a fire relieves cold.

The direction of behavior driven by a maintaining source of excitement is in most instances learned. An infant suffering from a recurring pin prick builds up a state of excitement in which lusty crying and much movement in arms, legs and trunk is manifest. Its behavior is remarkably like its behavior when hungry. The difference is that in

the case of the pin prick, offering it the nipple will not bring quiet for long. It is fair to assume that the motivation is similar in the two cases and that stomach spasms and perhaps other events are the source of the one condition of excitement just as the pin prick is the source of the other.

The baby is in the position of the cat in the puzzle-box. The situation is disturbing. Eventually some reaction brings relief. As a result of the fact that relief removes the disturbing situation, the movements last associated with the annoyer are protected from forgetting and remain the infant's response to the annoyance. The 'drive' is now directed. It tends to cause a specific line of action in the infant. The crying and struggle appeared to be aimless at first because they were not specifically adjusted to relief. After a movement of escape is learned as a response to the annoyer, the behavior exhibits *goal direction*. In the case of the infant, relief is ordinarily secured by getting the mother's attention. With practice in a large variety of situations, the infant develops a skill in attention-getting. Since most of its satisfactions are attained through the mother, the mother becomes a part of its desires; she becomes a stable interest.

The original strength of the connection between contact of the lips with nipple or finger is such that it acts as a relief from many annoyers because it tends to inhibit the behavior of annoyance. Nursing is thus learned in response to many situations for which it serves no biological purpose, and in the form of thumb-sucking may be distinctly non-adaptive.

Most of the drives of school children and of adults are far removed from original annoyers and depend on learning. Any well established habit directs behavior in the sense of motivating it, because habits become self-conserving in that interference with their execution acts as an annoyer and produces excitement and slight variation of the habit. The variation which permits the habit to be consummated or achieved tends to be preserved. The habit is preserved through changing to accommodate new conditions. When any routine has become habitual, interference with it is distressing.

This self-conserving character applies also to any behavior that is under way. Teachers and parents become well aware of the difficulty of making a child stop what he is doing and begin something else. The action itself is the signal for what has normally followed, which is the continuance of the action. Many commands and requests to children

fail to achieve an interruption of what is being done, and so are subject to associative inhibition. It is essential to insure that this interruption occurs, or that the direction is not given while conflicting energetic action is under way. It is often necessary to give a child time to stop what he is doing before giving the order or request.

In extreme and distressing instances this tendency of all habits to be self-conserving is illustrated by *compulsions*, in which the habit origin of strong motivation is conspicuous. In the housewife, cleanliness may become a compulsion merely because it has prevailed for years. The sight of dust and disorder has so regularly been the cue for attack that when this is not possible there is extreme distress. When a child is regularly made uncomfortable if hands or clothing are soiled and this pressure has been continued until the dirt is removed, the sight of dirt becomes the cue for hand-washing. In strong emotional conflict it may become not the sight of dirt but the sight of the hands themselves that is the cue for the act of washing, and a hand-washing compulsion is established. This may dictate almost continuous hand-washing through waking hours.

In some nail-biters the cue for the action is the sensation from the rough edge of the nail, and frequent skilled manicuring enables the child to break the habit because it removes for a time its imperative stimulus. In some cases the habit has been established as a relief from a recurring distress or anxiety, and it would be necessary to bring about a more fundamental retraining of the behavior leading to the conflict. Many acts owe their habit-forming nature to the fact that they have acted to reduce tension and anxiety. Gum-chewing, thumb-sucking, ear-pulling, face-rubbing, nail-polishing, grimacing, all are effective in bringing some relaxation from tension in anxiety states and are thus easily established as habits.

In the field of social psychology, analyses of common behavior in terms of associative learning will often display the actual determining conditions of behavior patterns that have been loosely classified as instinctive or as part of human nature. Freud's genius pointed out many such behavior origins, although the Freudian use of associative learning is on a naive and common-sense level. Children establish adjustments toward their parents. The characteristics of parents determine the type of adjustment that must be made, just as the construction of the puzzle-box limits the form of escape-habit that will be established. Some characteristics of parents are widespread. There are consequent

widespread traits in children to correspond. Parents are always more intelligent and usually stronger than a two-year-old child. The child must adjust himself to this superior intelligence and power. The habits he forms during this adjustment are the basis on which he confronts new situations, like a teacher. If home solutions have involved teasing, whining, and pleading, or independent action (the result of being left to fend for himself in many situations), or if emotional scenes and temper tantrums have been his outlet and solution, these forms of response are in the beginning transferred to the teacher. They are the child's only equipment. They can be changed when they fail to provide escape from difficulties. The child that has, because of the ways of his family, established a tendency to get out of trouble by lying and deceit, comes to the schoolroom with these devices prominent in his repertoire.

The almost universal phenomenon of the personification of hostile or friendly forces in the form of spirits and gods obviously depends on the fact that all infants must adjust their behavior to the adults about them. They learn to deal with human obstacles and to enlist human aid by entreaty, by abstaining from certain actions, or by gifts. Equipped with a repertoire of such responses, it is entirely natural for them to respond to frustration from nonhuman sources by the devices with which they are equipped. And the individual experience of each child with its own family will determine the type of response he makes to the world.

On a child's individual solution of the problem of an authoritarian father depends his equipment for reacting to the authority of the state when he is older. The attitude towards authority has been established in the home. Whether he is a rebel or a conformist depends on early experience in the family.

Interest in dominating or in being dominated depends on social experience and habit. The boy, who has regularly played with smaller companions who fall readily into compliance with his plans and his execution, becomes habituated to making and carrying out his own plans and will be restive and unhappy if thrown with the company of larger boys. As a result of his distress, he may find his own ways of continuing to lead and to command attention. He may develop violence or discover that clowning brings him the necessary attention. He may, if these fail, recast his basic pattern of dominating habits and become a solitary person.

In man, adjustment to the maintaining stimuli that give rise to that form of restlessness known as sex leads to many varieties of escape, depending very largely on early experiences of relief. The psychoanalytic literature recounts a great number of types of resulting adjustment, but is only vaguely aware of the nature of the associative learning which fixes sexual habits and interests. The psychoanalytic accounts are for the most part capable of analysis in terms of stimulus-response and the fixation of habits through association. Transfer, sublimation, repression, unconscious wishes, the wish-character of dreams, bungled acts, the role of symbolism, are all describable in terms of association and emotional reinforcement. The personifications on which Freud insisted, *id, ego, super-ego,* are names for classes of reactions depending on the development of specific desires after associative experience (*ego*) and on the development of verbal cues of social origin for behavior (*super-ego*). If the training of psychoanalysts permitted them the use and comprehension of the laws of learning, the psychoanalytic literature, which contains much valuable case information, could be rid of an enormous amount of myth-making and its accounts could be made clear. Brief accounts of essential facts would make it possible to introduce scientific method and verification into the jungles of psychoanalysis. Most present members of the cult, of course, are embarrassed by a strong, unconscious hostility toward common sense and clarity which would deprive them of prestige as initiates of the mysteries.

Naughtiness in the classroom is nearly always hit upon by trial and error as a device for restoring some norm to which the child is accustomed. Most of the child's play has required being noticed by his playmates. He cannot take part without such notice. In the classroom the teacher competes for this attention and provides the cause of restlessness that leads to the discovery of new methods of getting attention. Children who by virtue of their earlier experience have not been habituated to attention do not compete with the teacher for it in the school.

Motives are stimuli. Through past association the persistent stimuli that account for persistent behavior are responsible for movements directed toward *past* success. These movements lead to future success only when the world of events accommodates the individual with a repetition of the past. It is not the goal to be attained that accounts for our movements, but the effect of our last attainment on associative

learning. We preserve those habits that have not been subjected to reassociation. Among these preserved habits are likely to be our past methods of success, because success has protected them from change.

X. Reward and Punishment

The effectiveness of punishment in breaking habits depends entirely on its ability to cause other behavior *in the situation that was responsible for the offense.* If it fails to do this, its only contribution may be to make a repetition of the offense exciting. The effect of both punishment and reward depends entirely on what they cause the child to do in the situation. Their successful use requires an analysis in terms of stimulus and response. Under what circumstances does this offender perform the annoying act? No progress will be made unless by one means or another the offender is led to do something innocuous or commendable *in the same circumstances.* Only by this means can the circumstances be associated with something other than the offense. Whether a teacher is occupied with imparting knowledge and skill or in correcting undesirable behavior, the problem is always to bring about by one means or another the behavior desired in the presence of the situation that should in the future be associated with that behavior. This is why teaching is an art and requires experience and devotion.

XI. Goal Behavior

I have examined the statement of my seventh-grade informant very carefully for indications of goal-directed activities. Very clear-cut was the case of the coot which he was engaged in stuffing when I interrupted. When I indicated that I was satisfied with the interview, he returned to the coot. This goal, the nature of which rather puzzles me, had been established without any direction from older persons; in fact, there had been a considerable amount of adult discouragement and slightly veiled ridicule. It seems that a chapter on "How to Stuff a Robin" had been encountered in a boys' book and this had somehow operated to start conversation about stuffing birds while the coot was still alive. Any school program that could promote study as careful and intense as that given the book's directions would have made a sensation among educators. The account of the day at school is the source of some rather dubious goal information. Evidently the avoidance of making the teacher angry is a quasi-goal. Whether the

talking and the pen-throwing that were mentioned were goals or 'aimless' behavior stimulated by the general situation and special encounters with others would be difficult to determine. The accounts of the spelling, social science, geography, music, and reading are given with almost a scientific detachment. There is mention of "fancy doojigs" to work with in mathematics, which would imply doing something directed toward an end, something aided by the "doo-jigs." "Making things" in the shop is the only definite and explicit set of goals mentioned.

In my opinion there has been much careless writing by psychologists concerning the 'goal-directed nature of all behavior.' There is a strong tendency to confuse what makes the boy active with the end situation that will satisfy and reduce the activity. The goal is often spoken of as a cause. The absurdity of this is evident in those cases in which the goal does not yet exist until activity has produced it. Goals do not determine activity; but stimuli may incite activity that is directed toward a goal previously attained by the activity because the stimuli remain associated with the movements that ended in the goal attainment.

The confusion arises because there are so many instances in which the sight of the goal to be reached is one of the incentives to, and directors of, action. After the sight of an ice-cream cone has been accompanied by eating, that sight becomes an associative cue for salivary flow and eating movements. It interrupts whatever else the child is doing and furnishes the motivation of what he will now do. Even if the cone is taken out of sight, the behavior it aroused may substitute for it as the motivating stimuli. The child becomes active and restless. Escape from his distress will be by the method that was last successful in that situation. He will cry or plead or threaten. If old methods fail, there is a possibility that he will discover new ones.

The assumption that all behavior has a purpose is a childish mode of thinking left over from days when parents could all too readily answer the question, "Why?" concerning any action of theirs and insisted on asking that embarrassing question of the child. I have on occasion found it quite impossible to convince a child who insisted on knowing why I had driven into my garage with a rear door of the car open, that I had no plans for what happened. That an adult should act and that the act have unplanned results were beyond comprehension at the age of five.

It is far more correct to describe behavior in terms of problems than in terms of goals. It is the problem situation that accounts for the activity and gives an opportunity for the learning of new behavior. The goal merely names the solution, the situation that removes the activating problem and so tends to preserve the movements by which the goal was reached. The quality possessed by goals in general which renders us prone to learn devices for their attainment is not unanalyzable, as the goal-psychologists assume. Goals are situations whose attainment removes the maintaining stimuli for activity so that the movements of attainment remain faithful to the now absent stimuli. These stimuli cannot be reconditioned in their absence. Goals must include stimuli effective in changing behavior (and this is also true of effective rewards, whether they were anticipated or not), because behavior itself is the most important part of the current situation. The sight of food puts an end to search and starts the process of eating. To the finished product in the manual training class, response is no longer to use tools and sandpaper, but to exhibit, to admire, and to talk about.

When children acquire speech their behavior changes radically. Not only do words become the most important acts for attaining satisfaction but desires and goal behavior may be aroused in them and maintained through words. This means really that discontent and activity may be aroused through words. They now know what they want, we say. This means only that some word or phrase learned in connection with previous escape from distress is active in maintaining and directing their behavior.

The goal psychologists tend to confuse the word and the satisfaction. The word is not the goal, but an event in its own right, an event that takes part in bringing about the achievement-to-be. It is a very dubious indication of the nature of the final satisfaction. Even the most sophisticated adult describing his desires or purposes names unessential qualities or misses the point and names something only incidentally associated with satisfaction. We name to ourselves or to others a special dish. The name may be a cue for activity that through past experience guides us to a particular restaurant. Thinking of the word prevents us from straying from the path.

We arrive at the restaurant and give our order to the waiter. But if, at any of the preliminary stages, we were to be shown the actual results of our search, the half-digested stomach contents that are the

real goal in the sense that their presence in the stomach is what really satisfies us and inhibits hunger pangs, we should not continue our way to the restaurant. Even a suggestion of this more biological goal would discourage us.

Verbal purposes, announced intentions, rarely state the essentials of the goal achievement. A psychology that makes goal-achievement the fundamental law of behavior is dealing with a very tenuous and ambiguous set of data. A complete psychology must take account of failure and error as well as offer 'laws of least effort,' 'laws of goal-tendency,' etc. And the purposive description of behavior in terms of goal-tendency leaves out a whole field of accurate and useful prediction, namely, the prediction of movement, of style of execution, of the manner of the achievement.

XII. Word Habits

The teacher's interest in learning centers about the making and breaking of habits, the acquisition of skills, and the control of attitudes and interests. Teachers must achieve control of their subjects largely through the use of words, and the use of words complicates enormously the application of rules of learning to behavior. So far as I am aware, however, it does not introduce any new basic principles of learning. The central mechanisms responsible for associative learning are not replaced by other mechanisms when verbal behavior is involved. Words become signals for action, and situations and action become the evokers of words, through the same associative process that is evident in non-verbal learning.

The effectiveness of words lies in the often overlooked fact that they are human actions and are made up of actual movement. When the schoolboy speaks, he stimulates himself in ear and muscle just as he does when he plays a game or writes on the board. The effectiveness of verbal symbols lies in their past associations with the individual. When we address children in terms that have not in their own experience accumulated the meanings we have in mind, we are merely making noises, so far as they are concerned.

When we assert that a child learns only what he does, this includes that quiet behavior that may be called *inner speech*. It is quite possible, then, to learn with comparatively inactive listening. But if listening is actually passive, all that is being learned is to disregard the noise made by the speaker.

Many students are in the habit of taking extensive notes. Often all that is learned by this activity is the ability to jot down items that are heard. This capacity may not serve the student at all on future occasions when he is expected to show the effects of training. Stenographers may develop this skill to such a point that they show remarkable inability to recall the content of the material that they have transcribed.

In order to make listening profitable (or school work of any kind. for that matter) *it is essential that the student be led to do what is to be learned.* Since we are not concerned in making him a skilled notetaker, notetaking is of no value in itself. He may acquire as little of the verbal management of the subject as we are certain the seventh-grade pupil acquired of music under the teacher who talked all the time, while the children "didn't sing much." What is to be learned is an ability to retrace and develop the thought, comment upon it, question it, and associate it with other material. Unless the hearer is led to do this in inner speech, the lecture has been wasted. It is for this reason that recitation and discussion are used. They have their effect not only on those who take part in the discussion but also on all of those who are ready for such a part. The usefulness of a question is not in the fact that it elicits an answer from one pupil, but in that it elicits answers from all pupils, though only one speaks aloud. Readiness to recite means the rehearsed activity that is required for learning.

A student does not learn what was in a lecture or in a book. He learns only what the lecture or book caused him to do. What a lecture or a book will cause a man to do depends on many determiners. The words of the book may be scanned or the sounds of the lecture fall upon the ear without exciting any appreciable response save general orientation and behavior-stimulating attention. Long training in the schoolroom may have established this quasi-attention as a trouble-avoiding solution in the presence of teachers and this may carry over into unsupervised 'study' in which the student reacts through habit as if in the presence of a teacher. When the lecture or the text does excite active response it may be because it raises a problem. The essential nature of a problem is that it offers stimuli to conflicting responses or stimulates a response that cannot be completed because essential stimuli are lacking. Confronting a problem, an individual is in a state of conflict, and emotional reinforcement occurs. The individual becomes alert

and more energetic. Behavior becomes varied. Trial and error occur and eventually a line of response may eliminate the conflict and constitute a solution. In much teaching the problem is essentially a rehearsal of a lesson before the teacher and not a problem intrinsic to the book. The problem may be settled by a glimpse at someone's answer, if a mere statement of the answer has been in the past sufficient to solve the 'teacher problem.' What every teacher hopes for is that the problem will be intrinsic to the material and that an apparent contradiction in the text will bring such a conflict of perceptual response that emotional reinforcement will have the effect of new behavior and possible solution. This can happen only when the material of the text is within the range of the student's past associative experience and the symbols of the page have acquired for him approximately the associations that they have for the writer.

A student with adequate experience in the subject may fail to react because of the establishment of very superficial habits of study, but these can often be dramatically changed in a very short time. If he will read a section of the book that is making little impression and will then close the book and attempt to write down a summary of the essential information as he would give it to an intelligent friend, he will find on the first trial that he has little or nothing to write. This is, of course, because he did little or nothing save follow the words. But a second reading will be a very different activity. He is now searching for something to write and under these circumstances the seen words have an entirely different effect. They serve to suggest phrases and sentences which are rehearsed and occasionally rejected or corrected. The establishment of a written summary as a goal means actually that he has initiated the behavior of writing and the normal consummation of this will be the completion of the task. But the initiation of writing serves to eliminate irrelevant behavior and to fix attention on the topic, and under these circumstances what is read has a chance to suggest responses. It is this altered active reading that effects the mastery of the text, and not the actual writing that follows.

Boswell quotes Johnson in a very acute observation to the effect that travelers who can give an account of a detail of their journey are those who talked of it at the time. Their memories were based not on what confronted them but on how they responded to what confronted them.

XIII. Relation to Gestalt Theory

Some brief statement of the relation of associative learning, as sketched in this article, to the theories of the Gestalt psychologists is here necessary because naive readers often take them to be mutually exclusive. This is not the case. The phenomena described by Gestalt psychologists, insight, figure and ground, closure, etc., and the Lewinian notions of vector tendencies, behavior toward a barrier, etc., and the descriptions of behavior by such purposivists as Tolman in terms of goal tendencies and goal significance, are here acknowledged as correct and useful for certain purposes. All these descriptive categories represent attempts to describe and understand behavior without reference to the individual's past and entirely in terms of the present situation and the characteristics of the species, of the individual or of his age, or of the type of situation confronted.

Much human and animal behavior exhibits insight. What is here argued is that this names, not the explanation, but the problem. If we wish to know in advance how a problem will be solved, not merely that it will probably be solved, we must inquire into the previous experience of the individual in comparable situations, and our prediction will be based on association. What any boy will do when confronted with a problem in arithmetic depends on his previous classroom experience. For 'instinct' psychology, 'goal' psychology, and Gestalt psychology, which merely predict success or goal achievement, the teacher is a mere passive element in the situation. No suggestion is offered as to how the teacher can influence the result. In terms of association we can predict of the cat in the puzzle-box the specific movements by which the solution will be achieved on the next occasion, not merely that cats can in general escape from such boxes. We admit that those apes that have had previous 'trial and error' practice with sticks will be the ones to exhibit insight when confronted with the stick and the orange beyond the bars. Children of ten have their insight level, and are in general capable of solving problems of a certain grade of difficulty. This does not make less important the contribution of the teacher to specific problems and types of problems. No matter how bright a pupil, how high his insight level, a tremendous lot depends on what the teacher has led him to do and the circumstances in which it has been done.

Certain principles are given a very strange emphasis by Gestalt writers. One of these is the principle that the whole is not equal to the

sum of its parts. The writer has never yet met a person who believed that a puppy cut up into legs, head, and trunk was still a satisfactory puppy. Nor has he ever, before reading Gestalt theory, thought of this as an objection to the Euclidean principle that the whole is equal to the sum of its parts. This principle was taken to apply to area, length, weight, or other quantitative measures. Are we justified in suspecting that the Gestalt writers, during their preparatory-school days, took this statement in their geometries as something applying to puppyhood? Isn't it possible to let the principle stand in its correct and original meaning?

XIV. Summary

Learning is defined as the alteration in behavior that results from experience. The study of behavior and its alterations must select observable and nameable events. The two classes of events of chief importance for learning are stimuli, or the activation of sense organs, and responses, or the contraction of muscles and the secretion of glands. Because of the intricate system of internal sense organs responding to movements, the movements and postures of the body are important stimuli to further action.

All movement, all response, is normally occasioned by physical stimuli to sense organs. The best available basis of predicting behavior is the pattern of stimuli acting on sense organs.

In addition to responses in terms of specific movements, such as writing, reading, speaking, rising, sitting, etc., there are responses that affect blood-pressure, oxygen supply, blood sugar, or muscle tonus, and thus contribute to the possibility of action. By the word 'excitement,' we refer to those general bodily responses that reinforce action. By depression, we mean bodily events that diminish the possibility of action. These are both included under the term 'emotion.'

Both movements and emotional responses are subject to associative learning. The principle of association is as follows: Patterns of stimuli which are acting at the time of a response tend, on their recurrence, to occasion that response. A number of ambiguities in this statement are described, but the statement remains the basis of the effective control of learning.

One corollary of the principle of association is that we learn only what we do. This does not mean that we learn what we accomplish, but that we learn to repeat our specific movements and emotional re-

sponses under circumstances which have previously accompanied them, whether or not this is desirable or successful. We learn errors and bad habits as well as success and good habits. Theories of learning that are confined to the prediction of insight, of success, of goal achievement, fail to warn us of such outcomes and offer no help to the teacher interested in imparting skills or information.

In associative learning it is response that is associated with new stimuli. New response combinations result from conflict and interference and represent compromise responses to new combinations of stimuli. Such new response combinations may be subject to associative learning and attached to new stimulus patterns or signals.

Responses are dissociated from stimuli as well as associated with stimuli. This is always the result of the reassociation of the former stimuli with new responses that inhibit the previous response. Forgetting does not take place simply because time elapses, but because what had been learned has been actively unlearned by associating the former stimuli with new responses. Such unlearning or forgetting occurs when the stimulus of a response accompanies an inhibiting response, or when it is present after fatigue has prevented a response, or when it is given repeatedly with so slight intensity that it fails to evoke the response and hence becomes associated with whatever other responses are taking place.

Learning occurs normally in one associative episode. The reason that long practice and many repetitions are required to establish certain skills is that these really require many specific movements to be attached to many different stimulus situations. A skill is not a simple habit, but a large collection of habits that achieve a certain result in many and varied circumstances.

Motives are stimulus situations that keep the individual active until some specific goal is reached. By a goal we mean the removal of the maintaining stimuli responsible for the activity and excitement. This is essentially the puzzle-box situation; and when an individual is repeatedly placed in a recurring puzzle-box situation the movements that attain the goal or that remove the maintaining stimuli for activity tend to be preserved from unlearning. They cannot be unlearned because they have removed the individual from the situation and relearning or unlearning can take place *only in the presence of the stimuli for the response*. This is because unlearning or unconditioning or forgetting requires the association of those stimuli with new behavior.

In the school day described in the opening paragraphs of this article, there are some evident failures to establish the conditions absolutely essential to the desired learning. All of these consist in failure to induce the boy to do what he is expected to learn. Unless a response occurs it cannot be attached to any situation as its cue. When the music teacher "talks a lot" about music while the pupils are quietly listening or busy with daydreams or mischief, all that gets learned is the quiet subvocal activity that her words occasionally incite, or a skill in avoiding the teacher's attention while being active in mischief.

Learning at its best is illustrated by the boys engaged in stuffing the seafowl, with the aid of directions in a book. Here the desired activity is taking place and is being associated with appropriate words. Words are being made the signal, not merely for other words, but for performance. The 'lesson' will undoubtedly withstand forgetting and become a stable fixture in the boys' repertoire of abilities for the rest of their lives.

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CHAPTER II

CONDITIONING: OUTLINE OF A SYSTEMATIC THEORY OF LEARNING

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Educators busy themselves with problems of learning because all important forms of behavior are largely dependent upon learning. Indeed, the results of the learning process can be known only indirectly through observation of the subsequent behavior of the learner. Therefore this chapter, while primarily concerned with the theory of learning, is at the same time an outline of a theory of behavior.

The term 'theory' in the social (behavioral) sciences has a variety of current meanings. As here understood, a theory of behavior is a systematic, deductive derivation of the principles of behavior from a relatively small number of primary behavior principles or postulates, much as the theorems of geometry are all ultimately derived as a logical hierarchy from a few original axioms (20, pp. 1-11). Scientific theory in the physical sciences involves quantification, and the rigorous deduction of theorems from such quantified postulates usually requires the use of equations and the employment of higher mathematical procedures. While a real beginning has been made in this type of theorizing in the field of rote learning (20), only a relatively small portion of the behavior field has as yet been integrated in this rigorous manner. Because of the generally repellent nature of mathematics, little attempt at a rigorous logical structure will be made in the following pages, and the occasional necessary references to equations will be relegated to footnotes. Nevertheless, a definite attempt will be made to indicate the generally logical or systematic nature of the theory of learning, in so far as this can conveniently be done by means of informal discourse in the limited space available.

I. Environment, Organism, and Organismic Need

At the outset of the life of an organism there begins a dynamic relationship between (*a*) the organism and (*b*) its environment. For the most part, both environment and organism are active. The environment acts on the organism and the organism reacts upon the environment. This interaction goes on continuously throughout the life of the organism.

The environment of an organism may be divided into two portions, the internal environment and the external environment. The external environment may usefully be further subdivided into:

(1) The inanimate environment; the laws of this environment are those of the physical sciences.

(2) The organismic environment; this comprises especially organisms of the same species. The laws of this environment, when fully formulated, will make up roughly what are usually called the social or behavior sciences.

Because, for the most part, the laws of the behavior of the physical environment are not only much more simple but also much better understood than those of the organismic environment, the interaction of the organism with the inanimate part of its environment will here be considered first.

Since the time of Charles Darwin it has been necessary to think of organisms in a setting of organic evolution, and to think of structure and function in terms of *survival*—of the organism and of the species. The physiological study of vertebrate organisms shows that organismic survival demands a considerable variety of optimal conditions, such as air, water, food, temperature, intactness of bodily tissue; and for species' survival there must be at least the occasional presence of a receptive mate. On the other hand, when any of the necessities for either type of survival deviates materially from the optimum, a *state of need* is said to arise. In very many cases, where the need may be terminated by an appropriate change in the internal environment, this adjustment comes about by purely automatic physiological action (3). In many other cases, however, the states of need can be terminated, and so the survival of the organism can be facilitated only through changing the relationship of the organism to its external environment. At this latter point we enter the field of behavior proper.

As organisms have actually evolved, the changed relationship between organism and environment, which will consistently terminate the state of need, will ordinarily come about with uniformity only through a special kind of activity on the part of the organism. Most organisms possess a considerable assortment of muscles, usually with bony accessories, which are adequate to mediate such activity, provided the muscular contractions occur in the right combinations, amounts, and sequences. But the particular combination of muscular contractions necessary to satisfy a need depends (*a*) upon the nature of the need, (*b*) upon the exact state of the environment at the time, and (*c*) upon the reaction of the environment following the organism's activity; it is owing to this latter circumstance that the 'law of the environment' becomes so important. *The first necessity for survival under these conditions is that both the nature of the need and the nature or state of the environment must somehow be brought to bear upon the effectors (muscles and glands) which must participate in terminating the need.* The isolation of the principles or rules according to which this takes place constitutes the primary problem of behavior sciences.

The empirical study of organisms shows that as the first step in this coördination, millions of receptors mediate to the organism in remarkable detail the status of the various parts of the environment. These receptors are divided into several groups according to the particular type of energy to which each is responsive. The manner in which the status of the primary needs is brought to bear on the effector organs is not yet fully known; in the case of some needs, such as those of the reproductive activities, chemical substances in the blood known as hormones are involved, though it is probable that such substances may ultimately bring about indirectly the stimulation of characteristic receptors. Accordingly, the nature of the several needs is probably brought to bear on the effectors through the same type of mechanism as is the state of the environment.

The only activity receptors are capable of, upon stimulation by the proper or adequate form of energy, is the initiation of neural impulses. Now, the receptors are for the most part quite remote from the effectors whose action must mediate the reduction in the need. The neural impulses set in motion by the stimulation of the receptors are propagated rapidly over nerve fibers which ultimately make contact with the muscles. The neural impulse is of such a nature that when it impinges on a muscle the latter at once contracts longitudinally. The

maze of receptor impulses set in motion by the environment, both external and internal, must somehow be routed to the particular muscles in the exact amounts and sequence to produce the action which is necessary for survival. This routing is effected by the nervous system, chiefly by the brain, which in this respect acts as a kind of automatic central switchboard. For the most part, the ultimate *molecular laws* (the physiology of the nervous system) according to which this occurs are not yet known; however, a great deal is now known about the *molar laws* or coarse rules according to which this occurs. The aggregate of these molar laws, supplemented by occasional bits of neurophysiology, largely make up the present primary principles or postulates upon which the theory of behavior is based.

II. Random Activity and the 'Law of Effect'

Such a phenomenon as the prompt closure of the eyelid when the eyeball is touched suggests that the processes of evolution have laid down in the nervous system connections between certain receptors and the combination of muscles whose contraction is necessary to terminate the need, the existence of which is represented by the neural discharge of the receptor group in question. If, however, the first or reflex reaction does not terminate the flow of afferent receptor impulses representing the need, other portions of the body become active, the resulting movements being largely, but not quite, random.[1] With the persistence and the intensification of the receptor discharges repre-

[1] Much misunderstanding and misplaced criticism have centered around Thorndike's conception of random activity. There is no doubt that highly variable behavior is evoked in the newborn by conditions of need, especially if severe. In the present chapter the term *random* refers to this variability alone. It is assumed that the different movements evoked by a given state of need are determined by physiological principles not as yet known. Later in the life of the organism, after a certain amount of learning has occurred, there is superposed upon the innate partial randomness the results of this learning. The mechanism of this learned randomness is fairly clear: It depends upon the fact that a novel stimulus compound may possess components from other compounds previously conditioned to a variety of reactions. Some of these components will release strong reaction tendencies, and some will release weak ones; but the strongest reaction tendency, while occurring more frequently than any of the others, will not occur exclusively because of the spontaneous and irregular 'firing' of individual neurones. These irrelevant neural impulses coupled with the principle of afferent interaction (see Section VIII) quite fully account for the fact that reaction tendencies weaker than the strongest frequently become dominant, and so account for the variability of 'random' behavior.

senting the need, both the variety and the intensity of the random movements increase. As a rule the unlearned movements evoked by a need are sufficiently relevant for one of them, or some combination, to effect by chance the termination of the need; otherwise the organism would perish.

It is clear that the survival of the organism will be facilitated if, as the result of this success, the random act, or combination of acts, which chanced to eliminate the need should on subsequent occasions acquire an increased tendency to dominance over the other acts which did not lead to a reduction in the need. Such a strengthening is *learning*. The process of strengthening weak $s \rightarrow r$ connections, or the setting up of quite new ones, is called by Pavlov *reinforcement*. Because ordinarily in natural trial-and-error situations an act will not be reinforced unless it sets in motion a causal chain of events whose ultimate *effect* is a reduction in the need dominating the organism at the time, Thorndike (26, p. 4; 27, p. 6) has called the rule describing the basic process of the formation or strengthening of $s \rightarrow r$ connections, the *law of effect*.[1]

The 'law of effect,' as here understood, may be stated as follows: *If the central afferent receptor discharge (s_c) of a stimulus element (S_c) of a stimulus compound is active in the central nervous system at the time that a reaction (r_u) is evoked, and if at about this time there occurs a 'reinforcing state of affairs,' there will result from this conjunction of events an increment to a habit (${}_sH_r$)*. Much of the significance and most of the implications of this principle depend upon the meanings attached to certain terms, notably the term *habit* and the expression, *reinforcing state of affairs*.

III. Elucidation of the Expressions, 'Habit' and 'Reinforcing State of Affairs'

Practically all of the remainder of this chapter will, in a sense, be devoted to an elaboration of the meaning of the term *habit*, con-

[1] Actually it is not at all necessary that the reduction in the need be the effect of the event represented by the conditioned stimulus. Indeed, in most conditioned-reaction situations and in many trial-and-error situations this is *not* the case. For associative connections to be set up between a stimulus situation and a reaction, it is only necessary that a reduction in the need should occur in close temporal proximity to the conjunction of a stimulus discharge or trace. For this reason the expression, 'law of effect' is not strictly appropriate; it is used here because of its wide currency among educational leaders.

veniently represented by the symbol, ${}_sH_r$. In this the s represents the state of an afferent receptor discharge as it reaches some unstated region of the central nervous system, presumably in the vicinity of the sensory projection centers; r represents the activity of one or more effector organs (muscles or glands); and H represents the magnitude of a change in the state of the conduction structure of the nervous system whereby the propagation of the neural impulse, s, is routed into the efferent fibers leading to the organs which execute the reaction, r. A habit is thus an unobservable entity, at least in the present state of neurophysiology. It is, however, securely anchored to observable events in both temporal directions: (1) to the antecedent conditions which produce it, and (2) to the behavior which follows the subsequent delivery of the stimulus (S). It is thus by no means a metaphysical figment.

The concept *stimulus* must also be elucidated. Let us take vision as an example. There is usually a *stimulus object,* such as a die (Figure 1)

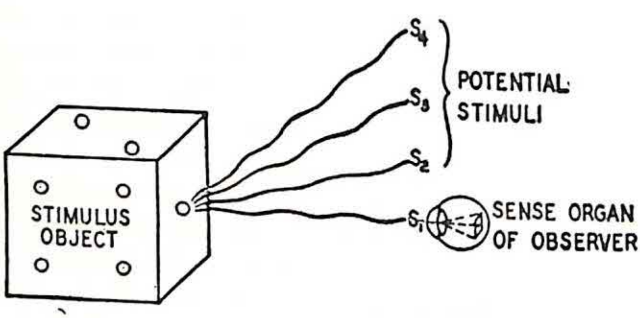

FIG. 1.—Diagram showing a typical stimulus object, a sheaf of potential stimuli, an actual stimulus (S_1), and the sense organ of the subject upon which the actual stimulus impinged (15, p. 11).

from which light waves may be reflected in all directions. Most of these light waves impinge on no receptor organ and are mere *potential stimuli.* Some of them, however, may impinge on the appropriate receptor organ of a subject, and the receptor organ will normally react by projecting a neural impulse along the afferent neural fibers to the brain; this group of physical light waves constitutes the visual *stimulus* (15).

But the environment is usually very complex and the state of even a small part of it, such as a vibrating tuning fork, may be conveyed to

the organism by numerous receptor modes jointly, e.g., through vision, sound, and touch; moreover, each receptor mode is mediated by the central afferent discharges of great numbers of individual receptor organs such as retinal rods and cones, auditory hair cells, the cutaneous receptors at the base of the hairs on the skin, and so on. Thus the stimulus (S) which is involved in the setting up of a habit, despite the grammatically singular form of the expression, is probably in all cases an exceedingly complex compound of physical energy elements.

It is clear from the foregoing that in the operation of the 'law of effect' some element or elements in the compound stimulus situation must evoke the reaction (r_u) in the first place, before it can be 'reinforced.' This raises the question as to what $s \rightarrow r$ connections are reinforced. Thorndike seems, around 1913, to have thought that only those connections or bonds were strengthened which originally evoked the reaction (26). On the other hand, the Russian reflexologists (Pavlov, Bechterev, and their pupils) have taken the view that not only old connections were strengthened, but quite new connections, involving stimulus elements not active (but present) in the original evocation, were set up (22). In his more recent writings, Thorndike seems also to have inclined to this view (27, p. 401-4); this appears in his later increased emphasis on "associative shiftings."

There remains of this preliminary explanation of the use of terms the difficult problem of stating exactly what constitutes a reinforcing state of affairs. It is probable that it will be impossible to state this in a wholly satisfactory manner until a great deal more is known about the neurophysiology of the learning process. At present, however, we are able on a rather coarse operational basis to attempt a molar elucidation of the concept. We have already indicated that from the point of view of biological survival a *primary* reinforcing state of affairs is the reduction in a need. However, the results from numerous ingenious experiments bearing on this problem indicate that by no means all reinforcing states of affairs are of this nature, particularly in the higher organisms and very notably in man. In higher organisms, through some process of learning not yet wholly clear, the power of reinforcement is extended to any stimulus situation which has been consistently and rather closely associated in time with the reduction in a primary need, or even with any *other* stimulus so associated. Stimuli (or the objects yielding these stimuli) which have thus become reinforcing states of affairs are said to be *secondary reinforcing agents*, and

reinforcements so mediated are called *secondary reinforcements*[1] (22, p. 33).

IV. The Conditioned Reaction a Special Case of the 'Law of Effect'

Much unnecessary confusion has resulted from the discrepant formulations of the basic law of habit formation, as propounded by Pavlov and Thorndike, respectively. Since a clarification of this matter will serve to elucidate still further the by-no-means-simple process of habit formation, a rather detailed comparison of the two formulations will be presented.

In Pavlov's type experiment (22, p. 32-33), a hungry dog was held by comfortable bands in a framework on a laboratory table. A bell was sounded for a few seconds and then some meat powder was blown into the dog's mouth by means of a rubber tube. The dog at once proceeded to eat and swallow the food with incidental flow of saliva. The latter was collected from one of the glands whose duct had been diverted by surgical means to the outside of the dog's cheek. The meat powder was called the *unconditioned stimulus* (S_u), the bell was called the (about to be) *conditioned stimulus* (S_c), and the secretion of saliva was called the *unconditioned reaction* (r_u). In Pavlov's formulation the incidence of the unconditioned stimulus (meat powder) on the receptors of the mouth constitutes the 'reinforcing state of affairs,' the fact that this stimulation was always followed by the ingestion of the food being ignored; both the existence of the need and its reduction as a

[1] Secondary reinforcing agents seem gradually to lose their power of reinforcement when not continuously supported by the primary reinforcing agent (reduction in need). This fact was discovered in Pavlov's laboratory (22) as an incident to the experimental proof of the genuineness of secondary reinforcement. In order to make this proof rigorous it was necessary to remove completely from the learning situation all primary reinforcement (feeding of the animals). Conclusive evidence of the reality of secondary reinforcement was found, but the habits so set up proved to be weak and the new stimuli thus associated with the first order secondary reinforcing stimuli proved to have very weak powers of serving as independent agents for effecting further reinforcements. This fact has led to the erroneous conclusion that secondary reinforcement plays a small role in behavior. The error arose from a naive interpretation of the artificial conditions which were necessary to the proof sought by the reflexologists. In ordinary life conditions, the primary reinforcement (reduction in need) is *not* absent, but only delayed; it is usually connected by the secure linkage of secondary reinforcing agents.

necessary sequel to the incidence of the unconditioned stimulus (S_u) were tacitly regarded as irrelevant. A conventional diagram frequently employed by American writers to represent the Pavlovian formulation is shown in Figure 2. A diagram representing the present conception

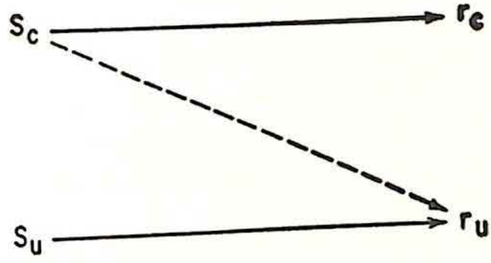

FIG. 2.—Conventional representation of the Pavlovian formulation of the process of conditioning. It is implicitly assumed by the makers of such diagrams that the mere conjunction of S_c, S_u, and r_u constitutes a reinforcing state of affairs, the emphasis falling upon S_u, regardless of whether the temporal conjunctions of the trace of S_c and of r_u are closely associated either directly or indirectly with the reduction of a need.

of this famous experiment is shown in Figure 3, where it may be seen that the conditioned reflex connection is readily derivable from the 'law of effect.'

A convenient reference experiment for illustrating the transition from the conditioned reflex to the typical 'law of effect' type of learning

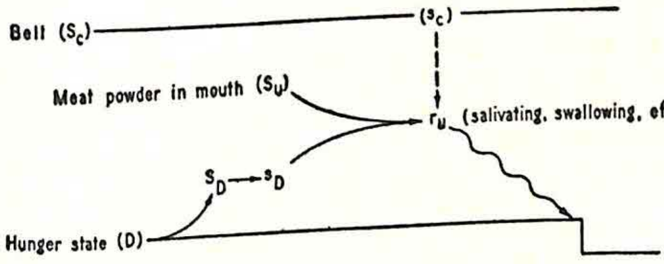

FIG. 3.—Diagram of the "law of effect" interpretation of Pavlov's classical conditioned reaction experiment. In this case S_c, s_c S_u, and r_u mean the same as described above. Note, however, the presence of the need or drive (D) of the drive stimulus (s_D) produced by the need. The reduction in the need (here symbolized by the fall, ‾‾‾|___, in the hunger line) represents the reinforcing state of affairs. As in Figure 2, the broken line with arrowhead represents the newly formed habit connection. The wavy line represents a non-stimulus type of causal sequence (19).

situation is the following, adapted from Skinner (29). An albino rat is fed repeatedly in a cubical soundproof box. At one side of the box is a brass panel in which a slit is cut. By the manipulation of a lever on the outside of the box, a small horizontal bar may be projected through this slit or withdrawn at the discretion of the experimenter (Figure 4). When the bar is introduced, the odor of moist food is carried through the slit to the animal by an air current; this odor is the first unconditioned stimulus (S_{u_1}) (Figure 5). In attempting to reach the source of the food odor the rat sooner or later presses the bar, which activates an electromagnet whose action delivers a pellet of food to the

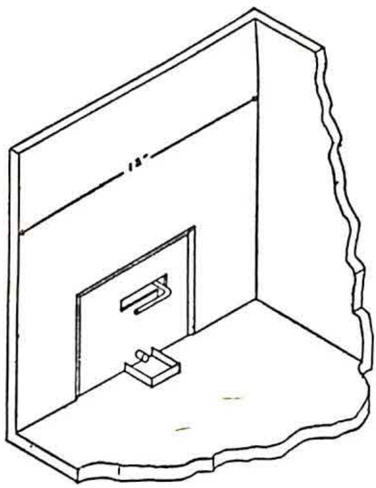

FIG. 4.—Diagram of a portion of the learning chamber of a Skinner-type apparatus. For explanation see text. Reproduced from Williams (29).

rat's food cup. The visual stimulation of the food pellet, a second unconditioned stimulus (S_{u_2}), causes the rat to take the food pellet in its mouth (r_{u_2}) and this is followed by eating, gustatory stimulation, a third unconditioned stimulus (S_{u_3}), and salivary secretion (r_{u_3}). Meanwhile, the bar has been withdrawn. Some minutes later the bar is again introduced and the same process is repeated. In the course of ten or twenty such repetitions the animal will gradually reduce from several minutes to a fraction of a second the time required to secure a pellet.

The diagrammatic representation of habit acquisition in the Skinner box situation, according to the 'law of effect' as here conceived, is given in Figure 5. This diagram shows that the habit structure here involved is far more complex than that set up in the typical conditioned-reflex

situation, since a whole chain of at least three connections is formed under the influence of a single primary reinforcement. The last of the three, a salivary reaction [1] ($s_{c_2} \dashrightarrow r_{u_3}$) is typically Pavlovian because it is the same as the reaction evoked directly by the food stimulus, food being the obvious reinforcing agent. The other two habits ($s_{c_1} \dashrightarrow r_{u_1}$ and $s_{c_2} \dashrightarrow r_{u_2}$) do not at all conform to the conditioned reflex formulation because the conditioned reactions in each case are distinctly dif-

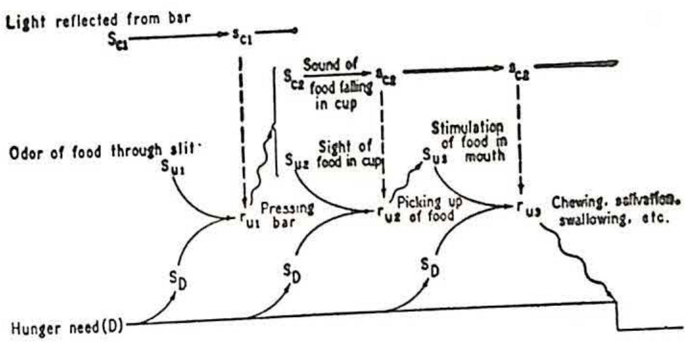

FIG. 5.—Diagrammatic representation of the formation of three habits in the Skinner box situation, one habit ($s_{c_2} \dashrightarrow r_{u_3}$) being a typical conditioned reaction of the Pavlovian type, the other two distinctly not (19).

ferent from that evoked by the gustatory stimulation of the primary reinforcing agent.

It may also be noted, incidentally, that the diagram of Figure 5 illustrates the principle that several *s,r* conjunctions, some of them more or less remote, may be effectively reinforced by the same reinforcing state of affairs, though the more remote the *s,r* conjunction chances to be from the reinforcing state of affairs, the smaller the increment of habit strength from a single reinforcement. Thus in Figure 5, presumably,

$$(s_{c_2} \dashrightarrow r_{u_3}) > (s_{c_2} \dashrightarrow r_{u_2}) > (s_{c_1} \dashrightarrow r_{u_1})$$

This set of inequalities based on the remoteness of the *s,r* conjunction from the point of reinforcement was originally known as the 'goal gradient' principle, but now is more properly called the *gradient of reinforcement* (25, p. 173; 11; 14, Theorem IX).

[1] The presence of this $s \rightarrow r$ connection in the Skinner box situation cannot be observed directly. However, its presence in comparable situations where observation is possible has been so uniform that its presence in the Skinner situation may be safely inferred.

From the foregoing paragraphs it has been seen that the conditioned-reaction type of habit may be derived from the 'law of effect' formulation, whereas it has not been found possible as yet to derive the law of effect type of habit from the conditioned reflex formulation. It accordingly seems fair to conclude that *the conditioned reaction is a special case of the 'law of effect'* [1] (13; 14, Theorem I).

The fact that most learning situations do not conform to the two narrow empirical formulations of the orthodox reflexologists has largely prevented them from applying realistically to the great bulk of behavior phenomena the many extremely valuable molar principles of behavior emerging from their ideally simple experimental procedures. But if the conditioned-reaction situation is a special case of the 'law of effect' situation, the molar laws emerging from the former should hold for the latter as well. Indeed, this a priori probability has been confirmed by a large volume of check experiments of the 'law of effect' type. Accordingly there is no reason why others, unhampered by reflexological orthodoxy, should not combine Thorndike's sounder empirical generalization with the numerous behavioral laws discovered by the economical conditioned-reflex mode of experimentation for the development of a comprehensive theory of the social sciences in general, and of a well-grounded theory of educational techniques and values in particular (19).

V. The Concepts of Excitatory Potential (${}_sE_r$) and of Reaction Threshold (${}_sL_r$)

It will have been noted that in the preceding formulation of the conditions under which habits are acquired it was not stated that following reinforcement a recurrence of the afferent receptor discharge (s_c) would certainly evoke that reaction, but only that the reinforcement would create the increment of a habit ($\triangle {}_sH_r$). Actually, the occurrence of an afferent receptor discharge, even assuming a habit of some strength, only *tends* to evoke the associated reaction. The word *tendency* in this connection implies much.

[1] It is possible that there may still be found some rare cases of conditioned reaction phenomena which cannot be derived from the 'law of effect.' Even so, there is reason to suppose that such cases, if any, will play no vital role in educational practice. The most marked case of apparent exception, the conditioned reaction to punishment, such as a brief electric shock, is explicable on the ground that the termination of the punishment (following a successful act) is the critical reinforcing agent, rather than the onset of the shock, as would be the conditioned-reflex interpretation.

It must now be pointed out that, ordinarily at least, a habit must be conjoined with a motivation or drive (D) before action will follow recurrence of conditioned stimulation (S_c). A recent experiment by Perin (23) suggests rather strongly that the relationship of habit strength ($_sH_r$) and drive (D) to the evocation of conditioned reaction is a multiplicative one.[1]

But even in the presence of a drive there is still uncertainty concerning whether the stimulus will evoke the reaction, because the strength of the *excitatory potential* ($_sE_r$) may not be great enough to overcome the resistance of the reaction mechanism, known as the threshold ($_sL_r$). In fact, s will not evoke r unless the excitatory potential ($_sE_r$) is greater than the threshold ($_sL_r$). Even with a powerful drive, if the habit strength is near zero the product of the two may still be too small to exceed the reaction threshold, in which case no reaction will occur. It is a familiar observation in learning that numerous reinforcements may be required before the excitatory potential becomes strong enough for the conditioned reaction to be evoked by the incidence of the conditioned stimulus (20, p. 138).

VI. Generalization and Stimulus Equivalence

When the product of the habit strength and an index of drive intensity yield an excitatory potential ($_sE_r$) in excess of the reaction threshold, the occurrence of a reaction is still uncertain because, strictly speaking, the conditioned stimulus (which, as we have seen, is nearly always a very complicated compound) is almost never repeated exactly even when it is conventionally said to be so. Experiments show, however, that conditioned stimuli need not recur exactly in the original form in order to evoke the associated reaction. Thus Hovland (7) found that when in human subjects a tone of 153 double vibrations per second was conditioned to the galvanic skin reflex, the reaction was evoked by tones not only of 153 vibrations, but also of 468 vibrations, 1,000 vibrations, and 1,967 vibrations. However, the latter three vibration rates evoked the reaction with decreasing intensities as the evoking stimuli deviated more and more from that employed during

[1] The equation expressing this presumptive relationship is:

$$_sE_r = f(D)\ (1\text{-}10^{-iR})$$

where $_sE_r$ is the excitatory potential of s to evoke r, D is some index of physiological need or drive, such as the number of hours of food deprivation (19), i is an empirical constant of the order of .02, and R is the number of reinforcements.

the conditioning process. Now, the successive vibration rates listed above are each separated by approximately 25 j.n.d.'s as measured by psychophysical methods. If the difference between the test stimulus and the conditioned stimulus be expressed in terms of j.n.d.'s, the generalization gradient takes the form of a simple negative growth or decay function,[1] as may be seen by a glance at Figure 6. Thus all stimuli on any given stimulus continuum, such as that of pitch, of sound intensity, etc., which are not too remote from the point of the continuum

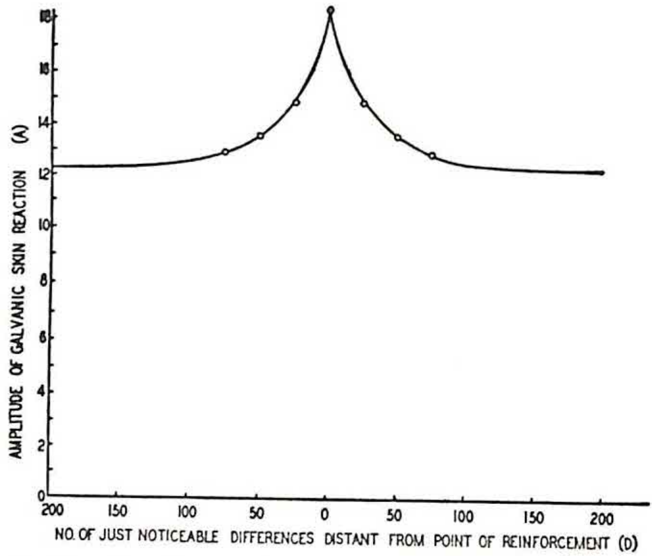

FIG. 6.—Double-winged generalization gradient of excitatory potential. Plotted from empirical data published by Hovland (7; 19).

originally conditioned, will evoke a reaction, but if a stimulus is too remote, the excitatory potential may fall below the reaction threshold and no reaction whatever will occur.

It is possible, however, for stimulus generalization to be extended indirectly throughout the range of a given stimulus continuum, even

[1] The most probable expression of this generalization gradient as indicated by available evidence seems to be:

$$_{s}\overline{H}_{r} = {}_{s}H_{r} \times 10^{-hD}$$

where $_{s}H_{r}$ is the habit strength (under the conditions of reinforcement), $_{s}\overline{H}_{r}$ is the effective habit strength (under the conditions of evocation stimulation), h is a constant of the order of .01, and D is the difference between the conditioned stimulus and the actual stimulus in j.n.d.'s.

though this range be many times the superthreshold span of the double-winged primary generalization gradient of the type represented in Figure 6. This possibility arises from the fact that a given reaction (r_x) may be specifically conditioned to very many points throughout this continuum. In that event many stimuli, such as S_a and S_z throughout this continuum will alike evoke r_x, and so s_x, the proprioceptive stimulus produced by r_x. Suppose, now, that r_y chances later to become conditioned to S_a. This will result in the situation shown in Figure 7.

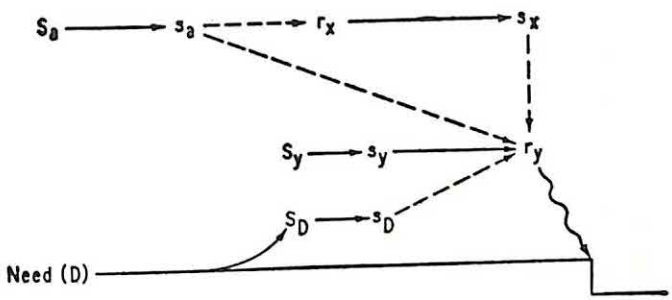

FIG. 7.—Diagram illustrating the conditioning process which is preliminary to indirect stimulus generalization and which leads, ultimately, to secondary stimulus equivalence. Strictly speaking, both s_a and s_D, as perseverative stimulus traces, should be shown as temporally coincident with r_y, except for difficulty of representation (19).

Suppose that after the conditioning process shown in Figure 7, S_z should act upon the organism's receptors. It is evident that the following sequence would take place:

$$S_z \rightarrow s_z \dashrightarrow r_x \rightarrow S_x \rightarrow s_x \dashrightarrow r_y$$

i.e., r_y would be evoked indirectly through the mediation of the (presumably) incipient evocation of r_x. Some human conditioning data of Shipley (24) seem to depend upon this mechanism (12, p. 36). Recently, Jane Birge (1) has presented convincing evidence that young children generalize according to this principle, the mediating reaction being spoken words.

VII. Conditioned Stimulus Compounds and Their Mode of Summation

We have seen that the stimuli sending discharges into the central nervous system at the time a reinforced reaction occurs are usually exceedingly complicated in the sense that they are made up of very many elements. There is some probability that any given element in the

stimulus compound will receive a certain loading of the habit tendency, and experiments seem to indicate that many of them do acquire such a loading. However, there is reason to believe that many of them do not, though the principles according to which reinforcement confers habit loading on particular stimulus elements are as yet not at all well known. It is known, however, that in simple and uncomplicated reinforcement situations a number of isolated elements, e.g., a light and a cutaneous vibrator, may be jointly and simultaneously conditioned to a given response, such as the galvanic skin reaction (18). In a study of this kind employing human subjects, both the light and the cutaneous vibrator showed a habit loading when presented separately, the light in one experiment yielding a mean reaction of 1.4 millimeters and the vibrator alone yielding a mean reaction of 2.8 millimeters.

At this point we encounter the reverse problem of how the component habit loadings combine to produce a joint effect when in the compound. In the above experiment it was found that when both stimuli were presented together under the conditions of reinforcement, the joint yield was 2.8 millimeters, or exactly the same as that of the vibrator when presented alone. In another experiment, in which the light and the cutaneous vibrator were each reinforced separately, the former alone yielded a mean reaction of 2.2 millimeters, the latter alone, a mean reaction of 3.71 millimeters, and both together yielded a mean joint reaction of 3.9 millimeters. In conformity with the above results, experiments show in general a marked tendency for the joint action of stimuli, conditioned either together or separately, to yield a mean joint reaction amplitude considerably less than the sum of the reaction amplitudes evokable by each stimulus component separately.[1]

On the other hand, if one or more elements of a conditioned stimulus compound be withdrawn from the compound, there is likely to be a reduction in the strength of the reaction, though the reduction will never be as great in amount as the magnitude of the reaction evocable by the component separately. It thus comes about that in case a stimulus compound as a whole should have an excitatory potential

[1] A tentative equation representing the mode of the summation of the excitatory potentials arising from the habit loadings borne by two components in a stimulus compound is as follows:

$$_{s_1+s_2}E_r = {}_{s_1}E_r + {}_{s_2}E_r - \frac{_{s_1}E_r \times {}_{s_2}E_r}{A}$$

where $_{s_1+s_2}E_r$ is the physiological summation of the excitatory potential borne by s_1 and s_2; $_{s_1}E_r$ is the excitatory potential borne by s_1; $_{s_2}E_r$ is that borne by s_2; and A is the physiological limit (15, p. 21).

($_sE_r$) only slightly greater than the threshold, and if one or more of the elements in the compound be lacking in a given stimulation, the delivery of the incomplete stimulus compound may evoke no reaction whatever.

VIII. Afferent Interaction and the Phenomenon of External Inhibition

We have seen that the loss of an accustomed element in a conditioned stimulus compound is likely to reduce the excitatory potential of the compound as a whole. We now take up the reverse problem, the effect of introducing an alien or unaccustomed element into a conditioned compound. In order to treat this question adequately we must introduce a new principle, that of *afferent interaction.* (19).

We have seen above that a habit is not a connection between either a stimulus object and a reaction, or even a stimulus (S) and a reaction, but is instead a connection between the reaction (r) and the state of the central afferent receptor discharge (s) when it reaches some point in the central nervous system at which connection is made with the fibers leading to the effector organs (tne muscles and glands) which perform the movements which have been reinforced. Now, there is much reason to believe that afferent receptor discharges occurring at about the same time interact and so modify each other, thus changing the characteristics of each s to those of s', say. Ample opportunity for such interaction is afforded by cross connections in the sensory projection centers of the brain, in the nuclei through which many afferent fibers pass on their way to the projection centers, and even in some compound receptor organs themselves, notably the retina.

It seems likely that numerous phenomena on which the Gestalt school of psychologists have very properly insisted may find their explanation in this neurological mechanism.[1] Thus a small bit of gray

[1] As a matter of fact, Köhler's hypothesis of 'dependent part qualities,' if stated in neurological terms instead of in terms of consciousness or experience, would be practically identical with the 'afferent interaction' hypothesis sketched above. While implicit in much of the Gestalt literature, the most explicit statement of the hypothesis of 'dependent part qualities' is contained in Köhler's recent book (21). It is a little surprising that the Gestalt psychologists have not made a wider and more explicit use of this hypothesis in the interpretation of behavior than they have yet done. That two approaches popularly supposed to be as diverse as that of Köhler and the present one find important use for what at bottom seems to be the same principle, encourages the view that current theoretical approaches differ far less than might be suggested by their diversity of terminology and the occasional acrimony of theoretical controversies.

paper on a blue ground will appear to have a yellow tinge, and the same bit of paper on a green ground will appear to have a pinkish tinge. The afferent interaction hypothesis states that the central afferent impulses arising from the receptors stimulated by the patch of gray paper while on their way to the point in the brain at which they are switched in the direction of the effectors, are acted upon by the simultaneous afferent impulses arising from surrounding regions of the retina, and thus each, and particularly the former, suffers a distinct distortion.

But we have seen that if the afferent impulse (s') received at the region of connection in the central nervous system is different from that (s) which was conditioned to the reaction, the excitatory potential (${}_sE_r$) thus set in motion will, by the principle of the generalization gradient, be less than would be the case if the originally conditioned central afferent discharge (s) had occurred. In this manner it comes about that the presence of an extra or alien stimulus in a conditioned stimulus compound can reduce the excitatory potential, and as a consequence the amplitude of the resulting reaction will be reduced, its latency will be increased, and the excitatory potential may even fall below the reaction threshold, in which case no reaction at all will occur. Thus the irrelevant stimulations resulting from an emotional upset will usually interfere with the capacity of a child to recite or to write an examination, and may temporarily abolish this capacity. This is the classroom equivalent of what Pavlov has called *external inhibition* (22, pp. 44 ff.). The presumptive analogue in psychophysics is Heymans' law (6).

IX. Behavior Variability or Oscillation (20, p. 74)

It is a matter of common observation that irrelevant stimuli are constantly impinging in large numbers on the receptors of an organism and that their incidence is essentially a matter of chance. These irrelevant stimuli may originate in the external environment (as when a fire truck goes shrieking down the street) or in the internal environment (as when a child suffers a panic of fear at the thought of failure in an examination or on a psychological test). In addition to these sources of external inhibition there is evidence that the individual nerve cells making up the tissue of the nervous system spontaneously generate neural impulses which 'fire' constantly, and more or less at random, into other portions of the nervous system.

Now all these randomly occurring irrelevant neural impulses would

naturally produce a continuously varying amount of distortion (afferent interaction) of the conditioned receptor discharges which chance to be operating in conjunction with the drive dominating the organism at any given time. This distortion of s to s', by the principle of the generalization gradient (Section VI), will cause a parallel diminution in the excitatory potential resulting from the stimulation, and so a continuous variability or oscillation in the level of behavior performance, even under quite constant conditions of antecedent training. (19).

It has long been a commonplace among mathematical statisticians that a large number of independent factors operating according to chance behave much as an infinite number of coins tossed simultaneously (2, p. 33). It follows that the joint outcome of the afferent interaction resulting from the chance impingement of a great many irrelevant stimuli would naturally yield an excitatory potential which would vary continuously as a definite function of normal or Gaussian probability. Accordingly, the behavior of a given individual, based on a particular habit and under apparently constant conditions of training and motivation, will vary from moment to moment in a largely unpredictable manner, except as to the general law of the quantitative distribution of the resulting movements.

In this principle of behavior variability or oscillation we find the explanation of why a child, while acquiring a motor skill or learning to spell a difficult word, will frequently give a more satisfactory performance at a point early in the training than it will at another point much later in the training when there is every reason to believe that the habit is much better formed than on the occasion of the earlier performance. It explains in a rational manner the sigmoid probability-of-response learning curve occasionally encountered in simple learning situations in which a single simple learned act is rising above the reaction threshold (20, p. 162), and the fact that the initial period of positive acceleration of such empirical curves is markedly less extensive than the later period of negative acceleration (19). It also explains the necessity of securing a considerable sample of the behavior of a given child if the measurement of even a single and very narrow capacity, such as rate of tapping, is to have much reliability. Finally, it explains the characteristic distribution of such test scores and, to some extent, the necessary preoccupation of educational psychologists, as well as of all social scientists, with statistics in general and with the Gaussian law of probability in particular.

X. Maladaptive Reactions and Experimental Extinction

We have seen (Section VI) that substantially the same movements are usually required for successful adaptation by a considerable zone of variation in the stimulus situation, and that the nervous system meets the situation by stimulus generalization, thereby permitting learning performed in one situation to function in a variety of other situations. We must now note that generalization is not always wholly adaptive. In many life situations a given reaction will be adaptive within a certain range of variability of the dominant elements of a stimulus situation, but not beyond this range. Now, by the principle of stimulus

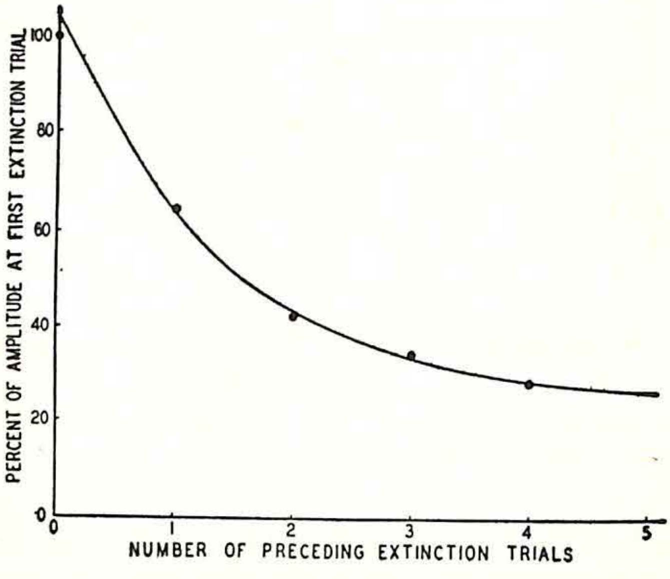

Fig. 8.—Graphic representation of the course of mean decrement in excitatory potential with successive unreinforced evocations of a learned act. Plotted from Hovland's unpublished data (7; 19).

generalization, stimuli beyond this range will at first evoke the reaction, though probably with less certainty, with less vigor, and with longer latency. But the execution of an act which is not reinforced is maladaptive because it represents a wasteful expenditure of energy, which in certain emergency situations might be lethal. The nervous system meets this biological dilemma with a corrective mechanism

called *experimental extinction* (20, p. 49). According to this principle, any reaction evoked by a stimulus compound which is not followed by a certain minimal degree of reinforcement, progressively suffers a diminution in its excitatory potential which, if the process continues, may ultimately fall to the level of the reaction-threshold. A graphic representation of this diminution as a function of the number of unreinforced evocations is given in Figure 8.

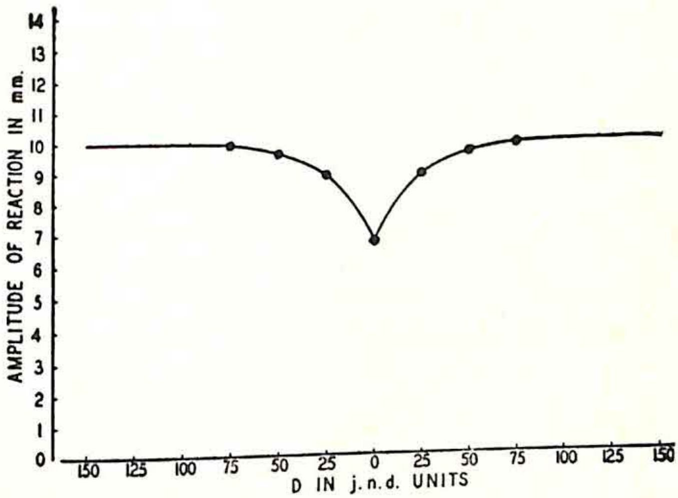

FIG. 9.—Double-winged generalization gradient of inhibitory or extinction effects. Plotted from empirical data published by Hovland (7; 19).

But just as it is necessary, owing to the continuously varying, nonrecurrent nature of stimulus situations, for excitatory tendencies to be generalized over an appreciable range if the results of learning are to be of adaptive value to organisms, so it is necessary, in terms of biological survival, for the results of experimental extinction also to be generalized over an appreciable range if its corrective value is to be appreciable. In an investigation of this matter Hovland (7) conducted an experiment on the generalization of experimental extinction, in a manner closely analogous to that mentioned above (Section VI) for the generalization of excitation effects. He found the gradient of generalized extinction effects to parallel closely that of the generalization of excitation (Fig. 9). Indeed, the generalization gradient of ex-

tinction was of such a shape that it would almost exactly neutralize the gradient of excitation if the two were centered at the same point as would, of course, be necessary if a single extinction of a conditioned reaction, which suddenly proved unadaptive, were to wipe out completely not only the conditioned reaction but all of its maladaptive generalization tendencies.

In the flux and complexity of the events of the environment to which organisms must adapt if they are to survive, it not infrequently happens that a situation to which a given reaction is adaptive may temporarily change in such a way that this reaction will not be adaptive, after which the reaction will again be adaptive. The nervous system is able to cope even with such superficial inconsistency of the environment. Adaptation in this situation comes about through the

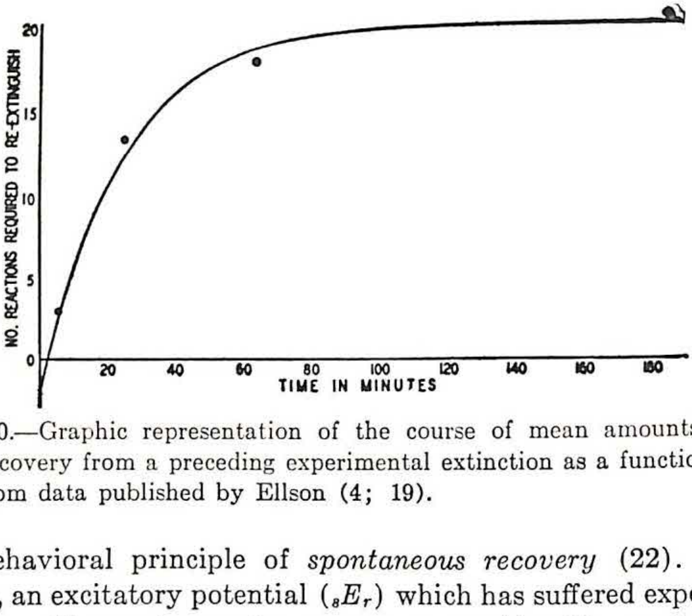

FIG. 10.—Graphic representation of the course of mean amounts of spontaneous recovery from a preceding experimental extinction as a function of time. Plotted from data published by Ellson (4; 19).

molar behavioral principle of *spontaneous recovery* (22). By this principle, an excitatory potential ($_sE_r$) which has suffered experimental extinction will spontaneously recover a considerable portion of its original strength after two or three hours. This function has been determined experimentally by Ellson, with albino rats (4). Ellson's findings are represented graphically in Figure 10.

XI. Sample of Trial-and-Error Learning (8; 19)

In the interminable permutations and combinations of environmental events, organisms will constantly find themselves in situations

of need in which some of the elements of the resulting stimulus compound will tend to evoke one reaction and some of the other elements will tend to evoke another (incompatible) reaction. Let it be supposed that one of the reactions is adaptive, that the other is not, and that the nonadaptive reaction tendency is so much stronger than the adaptive one that the oscillation ranges (Section IX) of the two action tendencies do not overlap. In such a situation the maladaptive act will occur at every stimulation, but will never receive reinforcement. As a result it will, through the action of experimental extinction, progressively decline in its excitatory potential until the range of its oscillation begins to overlap that of the weaker adaptive tendency. The weaker reaction tendency would begin at this point to function as overt action, and reinforcement would follow such action with consequent strengthening of the adaptive tendency. In spite of this increase in the strength of the weaker tendency, spontaneous recovery of the unadaptive tendency, together with behavior oscillation, will bring about the evocation of the maladaptive tendency many more times. However, the relative frequency of the two competing reaction tendencies will gradually shift in favor of the adaptive reaction until at length its strength will so greatly exceed that of the maladaptive tendency that their respective ranges of behavior oscillation will no longer overlap, at which point the adaptive reaction will occur exclusively. This is an example of what is called *simple trial-and-error learning* (8), a process of great importance in the lives of all organisms.

It is important to observe that in the case of simple trial-and-error learning just considered, a resumption of the training a few hours after a large, uninterrupted succession of adaptive reactions is very likely to evoke a longer or shorter sequence of the unadaptive reactions. This results from the spontaneous recovery from experimental extinction during the interval of no practice. Another characteristic phenomenon of simple trial-and-error learning is that if the component of the stimulus compound responsible for the maladaptive reaction tendency should be presented by itself, even at once after a long, unbroken sequence of adaptive reactions, it quite probably would show definite strength, as evidenced by the vigor of the reactions at first evoked, their short latency, and the number of unreinforced reactions required to produce extinction to the level of the reaction threshold (16).

XII. Simple Discrimination Learning (15)

The form of trial-and-error learning just considered involved a differentiation between two incompatible reactions evoked by the same stimulus compound. This is sometimes considered to be the discrimination between alternative reactions. Ordinarily, however, the term *discrimination* is reserved for application to situations where stimuli are differentiated. A typical situation of the latter kind is that in which a reaction is conditioned to one stimulus and the reaction tendency generalizes along the stimulus continuum beyond the environmental range in which the reaction is adaptive. Suppose, now, a stimulus value beyond the adaptive range recurs repeatedly: It follows that the reaction will be extinguished at this point to the level of the reaction threshold. The generalization of the extinction effects from

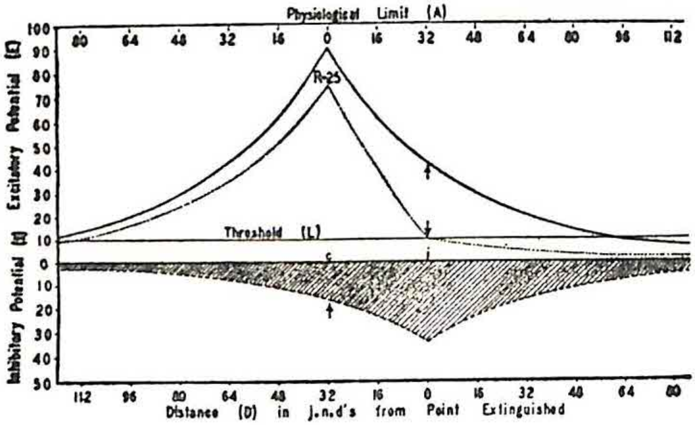

Fig. 11.—Diagrammatic representation of a theoretical generalization gradient of excitation (upper curve), of the generalization gradient of an extinction set up at a point 32 j.n.d.'s from the point of reinforcement of the former (lower shaded curve), and the result of the algebraic summation of the two (dotted line between the two). Reproduced from Hull (15).

the point on the stimulus continuum at which extinction occurred, together with the presumptive interaction of the respective excitatory and inhibitory tendencies on certain simple assumptions, is shown in Figure 11. There it may be seen that the generalization gradient of excitation toward the point of extinction becomes markedly steepened,

one excitatory potential remaining below the reaction threshold and therefore impotent to evoke reaction, and the other, while slightly reduced, remaining well above the reaction threshold, and so definitely functional. In this manner is explained simple discriminatory learning in which the presentations of the stimuli to be discriminated are separated by appreciable intervals of time.

Experiments indicate that only relatively coarse discriminations can be attained under these conditions; for finer discriminations, successive presentations usually separated by only fractions of a second or so are required. The explanation of this latter process requires a somewhat different set of principles; in particular it requires the principle of the patterning of conditioned stimulus compounds. We accordingly proceed to the consideration of this exceedingly important subject.

XIII. The Patterning of Conditioned Stimulus Compounds (19)

It is a fact that the reaction which will adapt an organism to a given environmental situation depends, as a rule, not upon any single element of that situation but upon a certain combination of elements. Since the environment is usually paralleled by a rather complete set of afferent receptor impulses, the reaction must be conditioned, not merely to a single element of the stimulus compound but, somehow, to the *combination* of afferent impulses. Perhaps no fact of behavior is more obvious or more important than this. Pavlov long ago pointed it out and conducted elaborate experiments to demonstrate its truth (22, pp. 141 ff.). The writers of most other schools of behavior have also recognized the problem. Neurologists have long puzzled over how the nervous system can mediate adjustments to such exacting conditions.

The fundamental analysis of the molar aspects of this behavior problem we owe to the reflexologists (22, pp. 141 ff.). Stated in its extreme form, the problem of the patterning of stimuli is that of conditioning a reaction to a stimulus compound in such a way that the compound as a whole will evoke the reaction, while the separate elements will show no tendency whatever to do so. Experiments show that there are two phases of the approach to this extreme state of affairs: (1) spontaneous patterning, resulting from the mere reinforcement of the compound as a whole; and (2) patterning by *differential reinforcement*, i.e., alternate reinforcement of the compound as a whole inter-

spersed with the nonreinforcement of the separate presentations of the stimulus components (22, p. 117).

From the point of view of the summation of the habit loadings of the several components of a stimulus compound as indicated in Section VII, the concept of patterning as just described appears at first sight to be impossible because the summation of any number of zeros of the components can never amount to a superthreshold reaction by the compound. This paradox is resolved by the principle of afferent interaction (Section VIII). By this principle it is possible to assume that the central afferent impulse (s) of each stimulus component will be modified in a characteristic manner to s' by every possible combination of accompanying stimulus elements making up a stimulus compound. This means that when each element of the conditioned compound is tested by itself, s will, by the gradient of generalization, evoke a smaller reaction than will s', its equivalent in the conditioned compound. As a result, if the reactions evoked by all the elements separately were summated by computation in such a way as to give the equivalent of a genuine physiological summation, this would be appreciably less than the amplitude of reaction evocable by the compound when presented as a whole. *The extent of this diminution is an indication of the extent of spontaneous patterning* (19).

If, however, the reaction to all the stimulus components (s's) are systematically not reinforced and the s''s are all systematically reinforced, in time the reaction to the components will be extinguished. There will be some generalization of extinction effects from the s's to the s''s, but much less than the whole load of inhibition, because of the falling generalization gradient, so that when this generalized inhibition is subtracted from the excitatory potential borne by s' there will be a substantial balance on the positive side after s has been reduced to complete impotence. In this way the stimulus compound may evoke a perfectly good reaction, yet the components evoke no reaction at all; this would be a case of perfect patterning of a conditioned stimulus compound. Thus the paradox of the patterning of stimulus compounds in an $s \rightarrow r$ system finds an explanation (19).

XIV. Compound Discrimination Learning and the Perseverative Stimulus Trace

There are many forms of compound discrimination learning. The analysis of only one of the simpler forms can be attempted here. Let

it be supposed that two tones so difficult of pitch discrimination that they cannot be successfully differentiated by simple discrimination learning (Section XII) are presented in the orders High - Low and Low - High. At the beginning of the process the order H - L is conditioned to a reaction, r. After this process has gone far enough to set up a fairly stable reaction, the stimulus L - H is presented.

Should a reaction to this stimulation be expected? Here we must introduce a new principle, that of the *perseverative stimulus trace* (2, p. 40). There is much reason (both neurological and molar) to believe that the afferent receptor discharge persists in the brain tissue as a self-propagating but progressively fading activity for some seconds and, in some cases, even minutes, after the termination of the action of the stimulus (S) upon the receptor. Let us say that originally L occurs a half second after the termination of H, and that r occurs a half second after the termination of L. In that case r will be conditioned to the compound made up of the 'old' receptor-discharge trace of H and the 'young' receptor-discharge trace of L, each as modified by the other through afferent interaction. If we let capital letters represent 'young' traces, and lower case letters represent 'older' traces, the habit set up in the first place will be,

$$s'_h \; s'_L \dashrightarrow r$$

On the other hand, the afferent impulse resulting from the stimulation L - H will be $s'_l \; s'_H$. We have seen (Section XII) that spontaneous patterning permits a considerable amount of generalized reaction. Therefore we expect that the subjects will give the reaction r to the stimulation L - H, though not as vigorously as to H - L. If, now, differential reinforcement be given to the two stimulus compounds, it follows that the one will finally be extinguished and the other will retain its power of reaction evocation (within the limits of the characteristics of the organism in respect to afferent interaction and to steepness of generalization gradients).

XV. Mechanism of Anticipatory Reactions and Short Circuiting (10)

One of the most common forms of adaptive reaction characteristic of higher organisms is that known as the *short circuiting* of behavior sequences, through which unadaptive links in such sequences are dropped out and ultimately abandoned. There are a number of

different mechanisms whereby the short circuiting of behavior sequences may occur, but only one of the simplest of these will be mentioned here. Let it be supposed that a drive stimulus is continuously active in a situation in which a number of reactions occur more or less by chance, and that a late act of the sequence sets in motion a series of events which results in a reduction in the drive, or need. This, we have seen (Section II), constitutes a primary reinforcing state of affairs. We have also seen that, by the principle of the gradient of reinforcement (Section IV), the last act of the action sequence will be most strongly reinforced and the others less and less strongly, the more remote they chance to be from the point of reinforcement. This reinforcement will therefore attach the final act very strongly to the drive stimulus (S_D) and to all other stimuli (s_1, s_2) common to the central afferent discharges persisting through the entire sequence of acts. It follows that at the outset of some later repetition of the stimulation initiating the series, these stimulus components will present the picture of the competition of excitatory tendencies shown in Figure 12, the relative

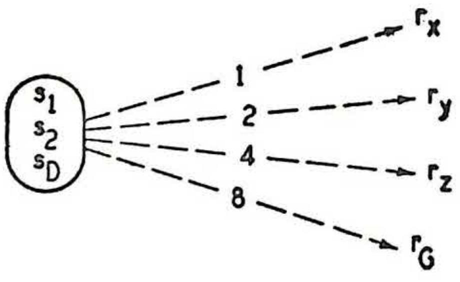

FIG. 12.—Diagrammatic representation of the competition among the several excitatory potentials initiated by the several elements of a stimulus compound. The numbers appearing on the several broken lines represent the excitatory potential of each action tendency according to the gradient of reinforcement.

strengths of the several excitatory potentials being indicated on the different arrows. However, the stimulus elements uniquely present at the occurrence of the various reactions are not represented. Under such conditions it is inevitable that r_G, the goal reaction (the one closest to the point of reinforcement), will dominate and the short circuiting of a behavior sequence will have occurred (9, pp. 519 ff.; 10, p. 492).

XVI. Compound Trial-and-Error Learning and Maladaptive Short Circuiting (10, pp. 490 ff.)

It frequently happens that the environment in which an organism finds itself is so constituted that a single act is not sufficient to reduce a need, several acts arranged in a particular sequence being necessary to bring about conditions which will do this. In that event it is evident that the gradient of reinforcement principle will produce short circuiting in a situation in which it will be positively unadaptive. Experimental studies on compound trial-and-error learning abundantly confirm this a priori expectation. Indeed, the tendency for such sequences to short circuit, i.e., for r_G to intrude and supplant r_2 (which by assumption must necessarily precede r_G in order for the environment to yield reinforcement), is one of the chief obstacles encountered by lower organisms in compound trial-and-error learning (10).

It is evident that the influence of the gradient-of-reinforcement mechanism must be overridden by some other mechanism, or a combination of such mechanisms, before compound trial and error can be achieved by the nervous system. The remedial mechanisms active in this case seem to be two: the perseverative stimulus trace and the principle of afferent interaction, mediating patterning. By hypothesis, r_2 must precede r_G before either of them will be reinforced. But r_2 leaves a perseverative trace. The activity of this trace in the brain tissue will, by the principle of afferent interaction, produce a characteristic change on the afferent discharges of the more stable elements of the stimulus situation which, when followed by differential reinforcement as it must be, will (Section XIII) at length set up a stimulus pattern (19) such that r_G will occur when, and only when, r_2 has just occurred. In this way the primary action of the gradient of reinforcement will be overridden and compound trial and error will finally be achieved.

XVII. Fractional Anticipatory Goal Reactions, Purpose, and the Pure Stimulus Act (10)

We must now observe that anticipatory or antedating goal reactions do not necessarily short circuit behavior sequences. Short circuiting occurs when the anticipatory goal reaction is of such a nature as to be incompatible with one or more of the acts of the sequence leading up to the point of reinforcement. If, however, the goal reaction is easily broken up into components, or fractions, it may be possible

for some unimportant physical component thus to be drawn forward to the very beginning of the behavior sequence leading to the reinforcement. The fractional anticipatory goal reaction is represented by the symbol, r_G. An anticipatory salivary reaction, a component of eating, would hardly compete with walking, manipulation, or even talking.

But acts, anticipatory or otherwise, produce characteristic proprioceptive stimulation, and a fractional anticipatory goal reaction must accordingly produce continuously a stimulation (s_G) characteristic of the point of reinforcement or goal situation. Thus a characteristic and dynamic element of the future goal runs like a thread through every moderately well-practiced behavior sequence terminating in a major reinforcement. Such a reaction is dynamic because it is a stimulus and because, through the gradient of reinforcement, it becomes conditioned to every movement in the sequence contributing to the attainment of the goal. Moreover, it becomes conditioned to every movement of every variant in the sequence of movements leading not only to every point of primary reinforcement but to every point of secondary reinforcement; i.e., not only to every primary goal but to every secondary or subordinate goal. Accordingly, s_G becomes a guiding stimulus leading to its own realization, to the final complete act of which it is a part. As such, the fractional goal reaction (r_G) is a *pure stimulus act,* i.e., an act whose only biological or survival function is that of producing a stimulus for the control of other action of more direct adaptive value. It is related to ideomotor action, not in the sense that it is evoked by ideas, but that it is itself the physical substance of an idea, the immensely important type of idea known to the classical psychologists as the guiding idea. As such it is believed to be at the same time the basic dynamic physical mechanism of intent and of those forms of behavior called hormic or purposive. In this situation, a present anticipation of an end does literally lead to the realization of that end (10).

XVIII. The Habit-Family Hierarchy and Response Equivalence (12)

In the infinite amount of compound trial and error which finally leads to the evolution of complex sequences or patterns of adaptive behavior, terminating in characteristic goal reactions, it is inevitable that owing to the variability in the environmental conditions on the

various occasions of reinforcement the behavior sequence which is actually reinforced will vary more or less extensively. It will thus come about that a considerable number of more or less alternative behavior sequences will be organized by means of the gradient of reinforcement. Since all the alternative behavior sequences have led to the same goal, all the component acts of all the sequences will alike be conditioned to the same fractional anticipatory goal-reaction stimulus (s_G), and in this sense will constitute a *family*. The beginning of some sequences will be more remote from the point of reinforcement than others, so it follows that these will, by the principle of the gradient of reinforcement, possess a weaker excitatory potential than the others and in this way the sequences will fall into a dynamic *hierarchy*. We accordingly call such a complex of potential alternative behavior sequences a *habit-family hierarchy* (14, Theorem XIII). Each member of the habit-family hierarchy is equivalent to all the others in the sense that each as a response will attain the goal, i.e., insure a particular type of reinforcement.

It may easily be shown (14, p. 27, Theorem XIII), though space is lacking here to do this, that if by trial and error an organism attains in a new situation reinforcement by one member of a previously established habit-family hierarchy, all other members of that hierarchy at once tend to become evocable by that situation.

XIX. Adaptation to the Social vs. the Inanimate Environment

So far we have considered the organism in an inanimate environment. At this point we pass over to the extensive and immensely important group of phenomena associated with the adaptation of the organism to a social environment made up for the most part by other organisms of its own species. Contrary to the belief of many social philosophers, the *primary principles* of behavior operative in social situations are no different from those operative in inanimate environments. The difference lies in the *conditions* (17, p. 122) under which these basic principles operate; i.e., the combination of environmental conditions and sequences under which a given act or action sequence will be followed by reinforcement. In reacting to an inanimate environment the organism's behavior must conform to the laws of the physical world in order that reinforcement shall follow its acts; *in reacting to an organismic or social environment the organism's behavior must conform to a set of laws of the same sort as those accord-*

ing to which its own behavior occurs (17). It thus comes about that very many of the *secondary* laws of social adaptation differ strikingly from those of adaptation to inanimate situations. There is space here merely to mention one or two of these: Various forms of deception and entreaty in emergencies may be followed by reinforcement in social situations, but never, except by chance, in an inanimate situation. Sometimes through the faulty (too wide) stimulus generalization, reactions originally reinforced in social situations may be evoked in non-social emergencies, in which case we have various forms of verbal entreaty, incantation, and other magical practices.

Perhaps the most striking single factor in the adaptation to the social environment is that organisms not only behave according to the 'law of effect,' but when of sufficiently high order are able to control the behavior of other organisms by applying the 'law of effect' to them. A concrete outcome of the operation of this principle is the fact that all stable social relationships, e.g., economic exchange, involve *reciprocal reinforcement*—something in the relationship must reinforce the necessary activity involved, as otherwise it would be extinguished and the relationship terminated (17).

XX. Social and Individual Symbolic Behavior

Perhaps the most typical form of social behavior is found in speech and other types of communicational pure stimulus acts; i.e., acts whose function is purely to stimulate other organisms. Our primary interest in language here is in a kind of feedback from the social to the individual economy, most readily seen in the reaction to the inanimate environment. This is the immensely important role that verbal symbols (acquired originally in social situations) later play in the solution of problems presented by a purely inanimate environment. Perhaps originally through the aftereffects of the reinforcement resulting from the reduction of needs mediated by following verbal directions of symbolically more sophisticated persons, a child begins tentatively to secure analogous stimulation by himself speaking relevant words. By trial and error certain combinations or sequences of self-uttered words are found to mediate problem solution and are therefore reinforced; other combinations do not mediate the reduction of needs and are therefore extinguished. Those combinations of symbolic acts which successfully mediate problem solution are finally formulated as the *rules*

of correct reasoning. These make up the substance of what is called *logic*.

It is believed that this form of behavior is the most highly adaptive, the most efficient and flexible means for mediating survival ever evolved. While there are probably numerous habit mechanisms as yet unanalyzed from the mass of phenomena at present indiscriminately called intelligence, it seems likely that one of the most important of these is the capacity to use symbols, mostly verbal, in individual problem solution. Indeed, it is not improbable that the high correlation of vocabulary with 'general intelligence' is related to this hypothesis, so vigorously championed by Watson (28) and by Guthrie (5).

XXI. Practical Educational Applications

On the basis of the preceding principles it seems reasonable to suppose that if children from an early age were systematically trained to find the solution of genuine individual problems by means of their own symbolic processes, intellectual education might be far more effective than it is at present. However, the situations would need to be such as would not be readily solved by manual or other instrumental trial-and-error behavior. A good-sized volume might be written in elaboration of this one educational principle.

Because of the severe limitations on the space available for the present chapter, no attempt will be made to draw detailed educational maxims from the preceding theoretical outline. In spite of certain sharp differences between the primary assumptions of Professor Guthrie's chapter and this one, the two systems have a strong kinship; if practical morals were to be drawn from the present system they would agree almost in detail with those put forward by Professor Guthrie.

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CHAPTER III

CONNECTIONISM: ITS ORIGIN AND MAJOR FEATURES

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According to Warren's *Dictionary of Psychology*, connectionism is "the doctrine that all mental processes consist of the functioning of native and acquired connections between situations and responses (Thorndike)." More popularly it is known as the bond theory of learning. As the above definition indicates, it is always associated with the name of Thorndike, but does not form a 'school' in the sense that the Gestalt and psychoanalytical theories form schools.[1] Neither Woodworth[2] nor Heidbreder,[3] for instance, devotes a chapter to connectionism, though Thorndike is too important a figure to be wholly neglected by these writers. He is mentioned, therefore, by Woodworth mainly in connection with animal learning and by Heidbreder in connection with learning and measurement. Yet connectionism, without being a 'school,' has been far more important in the field of practical education than any of the schools these writers deign to discuss.

* As this yearbook was being prepared for printing, announcement was made of the death of Professor Sandiford at Toronto on October 12, 1941.

[1] By deliberate intent, instead of discussing the variations in connectionist doctrine, as exhibited by Thorndike's students and disciples, the writer has mainly confined this chapter to Thorndike's own statements. Thorndike's name, therefore, occurs with distressing frequency. Yet this is justified, for Thorndike *is* connectionism, just as Freud *is* psychoanalysis. Further, instead of dealing with meticulous details of doctrine, the writer has selected those aspects that he considers the major features of connectionism. Thorndike's contributions are so voluminous and he has pioneered in so many fields that any selection of topics becomes almost arbitrary. It is certain that other students of Thorndike would have made a different choice.

[2] R. S. Woodworth, *Contemporary Schools of Psychology*. New York: Ronald Press Co., 1931.

[3] Edna Heidbreder, *Seven Psychologies*. New York: D. Appleton-Century Co., 1933.

I. Main Features of Connectionism

The following outline gives the main distinguishing features of connectionism, some of which will be treated more fully in the later sections of the chapter:

(1) Connectionism is an outgrowth of the association doctrine, especially as propounded by Alexander Bain. Thorndike was a pupil of William James, some of whose teachings were derived from Bain and the British associationists. Connectionism, therefore, through associationism, has its roots deep in the psychological past.

(2) Connectionism is a theory of learning, but as learning is many-sided, connectionism almost becomes a system of psychology. It is as a theory of learning, however, that it must stand or fall.

(3) Connectionism has an evolutionary bearing in that it links human behavior to that of the lower animals. Thorndike's first experiments were with chicks, fish, cats and, later, with monkeys. From his animal experiments he derived his famous laws of learning.

(4) Connectionism boldly states that learning is connecting. The connections presumably have their physical basis in the nervous system, where the connections between neuron and neuron explain learning. Hence, connectionism is also known as the synaptic theory of learning.

(5) Connectionism is atomistic rather than holistic or organismic, since it stresses the analysis of behavior in order to discover the elements that are connected or bonded together. The sum total of a man's life can be described by a list of all the situations he has encountered and the responses he has made to them. Those who hold that the whole is greater than the sum of its parts have strongly attacked the atomism of the bond theory. Connectionism takes the organism for granted and regards Gestalt psychology as somewhat mystical in tone because of its steadfast refusal to analyze behavior into its elements. If, as Tolman maintains, behavior can be classified either as molar or molecular, connectionism wholeheartedly accepts the molecular as its field of study.

(6) The connectionist principle of associative shifting has relationships with Pavlovian conditioning, which Thorndike regards as a special case of associative learning.

(7) Connectionism has also some affinities with Watsonian behaviorism in that it stresses the mechanistic aspects of behavior. Neither one finds it necessary to evoke a soul in order to explain behavior. Con-

nectionism breaks with behaviorism in regard to the stress it places on the hereditary equipment of the behaving organism.

(8) Some connections are more natural than others. We grow into reflexes and instincts without very much stimulation from the environment except food and air. In other words, we mature into reflexes and instincts, but we have to practice or exercise in order to learn our habits. These hereditary patterns of behavior (reflexes and instincts) form the groundwork of learning. Most acquired connections are based on them and, indeed, grow out of them. Even such complex bonds as those which represent capacities (music, mathematics, languages, and the like) have an hereditary basis.

(9) According to connectionism those things we call intellect and intelligence are quantitative rather than qualitative affairs. A person's intellect is the sum total of the bonds he has formed. The greater the number of bonds he has formed, the higher is his intelligence.

(10) Connectionism experiments ceaselessly. While experimentation in learning is not restricted to connectionism, yet the predilection that connectionists have for proving all things and holding fast to that which is good, has served them well in the schoolroom. Connectionism, above all other theories of learning, seems to be one that the classroom teacher can appreciate and apply. While the statistics which summarize the experiments have been decried as the products of a mechanistic conception of behavior, nevertheless they have done more to make education a science than all the theorizing of the past two thousand years.

II. A Recent Statement of the Nature of Connectionism

Thorndike is such a voluminous writer that it is difficult to summarize his position on any single question, or, indeed, to pin him down to a specific position. In order to remove any doubt the reader may have on the matter, the following recent statement of Thorndike's position is given:

> A man's life would be described by a list of all the situations which he encountered and the responses which he made to them, including among the latter every detail of his sensations, percepts, memories, mental images, ideas, judgments, emotions, desires, choices, and other so-called mental facts.
>
> Using S and R as symbols for 'situation or state of affairs encountered by the man,' and 'response made by him,' and using →

as a symbol for 'evokes,' 'evoked,' 'leads to,' or 'led to,' a man's life would be expressed as a list of millions of events like:

$$S_1 \to R_{146},\ S_{29064} \to R_{17261},\ S_{104618} \to R_{3184},\ S_{21} \to R_{269}, \text{ etc., etc.}$$

A man's nature at any given stage would be expressed by a list of the R's which he would make to whatever S's could happen to him, somewhat as the nature of a molecule of sugar might be expressed by a list of all the reactions that would take place between it and every substance which it might encounter.

There would be one important difference, however. If each $\to$ had attached to it a number expressing the probability that the S in question would evoke the R in question, most of these probabilities would be near 0 or near 1.00 for the behavior of the molecule of sugar; but in the case of the behavior of a man our knowledge would not often suffice for that. In human behavior our ignorance often requires the acknowledgment of the principle of *multiple response* or *varied reaction* to the same S by a person who is, so far as we can tell, the same person. Instead of $S_{79} \to R_{261}$, with a probability of 1.00 and $S_{79} \to$ any other R than R_{261} with a probability of 0, we often have to expect something like:

$S_{79} \to R_{261}$	with a probability of .80
$S_{79} \to R_{2611}$	with a probability of .06
$S_{79} \to R_{2612}$	with a probability of .04
$S_{79} \to R_{2613}$	with a probability of .03
$S_{79} \to R_{2614}$	with a probability of .02
$S_{79} \to R_{2615}$	with a probability of .03
$S_{79} \to$ all other R's	with a probability of .02

If John Doe were really the same person in every particular on the hundred occasions he would always respond to S in one same way at each of its hundred occurrences, but he will not be. Even when we can detect no differences in him there will be subtle variation in metabolism, blood supply, etc.

If a man's nature at two dates, say at age 20 years 0 days and at 20 years 100 days, were expressed by two $S \to R$ lists, changes in the man during the 100 days would be shown and measured by the changes in the R's evoked by the same S's, or in the probabilities attached to the $\to$'s connecting the same R to the same S.

Important sorts of change are the strengthening of previously existing tendencies, the growth of new tendencies, the weakening and the abolition of previously existing tendencies. All four sorts are best thought of in terms of S, R, and $\to$. When $S \to R$ with a probability of K changes to $S \to R$ with a probability greater than K,

a previously existing tendency has become stronger. When $S \rightarrow R$ with a probability of 0 or near 0 acquires an appreciable probability, a new tendency has appeared. When $S \rightarrow R$ decreases its probability, there is weakening. When the decrease is to 0, the tendency has been abolished.[a] [1]

III. Connectionism at Work

In any place where people are being trained we see connectionism at work—in the classroom, on the playing fields and in the factory. Let us, therefore, describe a few of these situations. First the teaching of spelling. Connectionism has selected the words that should be taught to pupils at the various grade levels. The methods of teaching these words have been meticulously appraised in scores of carefully conducted researches. Nobody, today, expects a child to learn spelling by suction, or to learn the 30,000 words which were the content of the older spellers. The subject has been carefully organized, element by element, step by step, so that normally the child finds little difficulty with his spelling after he graduates from the elementary school. The modern teaching of spelling illustrates connectionism at its best.

Similarly, arithmetic has been remade as a subject of study in the elementary school by Thorndike and other connectionists. The elements of skill and knowledge which go to the making of a skilled arithmetician have been analyzed and suitable exercises devised to develop them. The number combinations, the steps in two-column addition, the elements which enter into a knowledge of fractions, and so forth, are now taught step by step until the learner achieves proficiency. In some specially fortunate schools it has been found possible to carry on such important investigations as the testing of the various methods of teaching subtraction to find out which one gives the best results.

In regard to reading, modern languages, mathematics, science, music, and the like, the same story can be told. In the schools, the analysis of educational situations is practiced continuously and the vast improvement shown in the teaching of these subjects during the present century can only be regarded as mainly due to the impact of connectionism on modern teachers.

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[a] $S \rightarrow R$ with a probability of 1.00 may become still stronger in the sense that it will still occur under more and more adverse conditions and will remain after longer and longer periods of lack of exercise.

[1] E. L. Thorndike, *Human Nature and the Social Order*, pp. 5-6. New York: Macmillan Co., 1940.

In the factory, apprenticeship methods are mostly in vogue. The learner is taught to do one job at a time until he achieves skill with the whole. The instruction is in the best traditions of connectionism, since the jobs are analyzed into their elements and specific training given in each of them.

On the playing fields, whether it be drop-kicking in football or pole-vaulting over the bar that the coach is trying to teach, the method is that of connectionism. From careful analysis, observation, and experiment, the football coach has discovered the elements that enter into successful drop-kicking—how the ball should be held, how the ball should be dropped, how the leg should make the kick, the importance of timing, etc. One by one, each of these elements is imparted to the learner and endless practice insisted upon. In this way, and apparently only in this way, can the good 'footballer' be made. Similarly, the good pole-vaulter is made by teaching him the elements, one at a time, and insisting on concentrated practice—how to hold the pole, how far to run before beginning the vault, how to roll the body over the bar after the pole is released, and so forth. While separate practice of each element apart from the others is hardly possible, nevertheless by concentrating first on one element, then on another, the whole process begins to work smoothly and the pole-vaulter achieves his maximum height.

In contrast to these connectionistic training methods, one has only to imagine a football or track coach imbued with Gestalt or other organismic principles. How could the football coach, for instance, train his team without the meticulous analysis of situations commonly confronting football players in actual games? It is difficult to picture any football coach urging a player to practice drop-kicking in order to develop his personality. What is beyond dispute is that participants in Rose- and other-bowl games have been trained on connectionistic lines. And the closer the adherence to these principles by the coach, the more successful his team appears to be.

IV. The Associationistic Background

It is usual to trace the concept of association to Aristotle (384-322 B.C.), but, in truth, that individual had little formal knowledge of the subject as we regard it today, namely, as the establishment of functional relations among psychological activities and states in the course of individual experience. He thought that we could not perceive two sensations as distinct at one and the same time, but thought they could

combine or fuse into one. Aristotle enters the association picture through his types or laws of association which were first enunciated in his work on memory. He states:

> Whenever, therefore, we are recollecting, we are experiencing certain of the antecedent movements until finally we experience the one after which customarily comes that which we seek. This explains why we hunt up the series, having started in thought either from a present intuition or some other, and from something either *similar*, or *contrary*, to what we seek, or else from that which is *contiguous* with it.[1]

Little is heard about either the doctrine or the laws until Hobbes (1588-1679) revived the subject in several of his writings, chiefly in *Leviathan* and in *Humane Nature*. According to Hobbes, association was dependent upon the "coherence" of past ideas. He also pointed out that the succession of conceptions in the mind may be casual and incoherent, as in dreams, or may be orderly and regulated as by some design. The first type we now call uncontrolled association; the second, controlled association and purposive thinking. Of the three Aristotelian laws, Hobbes pinned his faith mainly to contiguity in time, although his controlled association exhibited the principles both of contiguity and similarity. Thus he states, "The cause of the coherence or consequence of one conception to another is their first coherence or consequence at that *time* when they are produced by sense."[2] In another place he says that "those motions that immediately succeeded one another in the sense, continue also together after sense: insomuch as the former coming again to take place and be predominant the latter followeth."[3] Thus, in this first explicit statement of the doctrine of association the belief that it is mainly due to contiguity in time is expressed, and this belief runs throughout the whole history of associationism.

The phrase "association of ideas" we owe to John Locke (1632-1704). According to him some of our ideas have a natural correspond-

[1] Aristotle, *The Parva Naturalia: De Memoria et Reminiscentia*, 451b-452a. (Edited by Smith and Ross, 1908.)

[2] Thomas Hobbes, *Humane Nature, or The Fundamental Elements of Policie*. (In *English Works*, Ed. Sir William Molesworth, 1840. Vol. IV, Chap. IV, pp. 14-15.)

[3] Thomas Hobbes, *Leviathan, or the Matter, Form and Power of a Commonwealth, Ecclesiastical and Civil*, Part I, Chap. III.

ence and connection one with another; others owe their connection to chance or custom. These ideas, that are not all of kin, are difficult to separate; they always keep company, and no sooner does one come into the understanding but its associate appears with it. "The ideas of goblins and sprights have really no more to do with darkness than light: yet let but a foolish maid inculcate these often on the mind of a child, and raise them there together, possibly he shall never be able to separate them again so long as he lives; but darkness shall forever afterward bring with it those frightful ideas, and they shall be so joined that he can no more bear the one than the other. . . . Many children imputing the pain they endured at school to their books they were corrected for, so join those ideas together, that a book becomes their aversion, and they are never reconciled to the study and use of them all their lives after: and thus reading becomes a torment to them, which otherwise possibly they might have made the greatest pleasures of their lives." [1]

While Locke made possible an association psychology which started with the impact of experiences on a blank mind and worked out the laws governing the sequences and interconnections of experiences, and, further linked association of ideas to the art of teaching, it was David Hartley (1705-1757) who turned association into a system of psychology. Moreover, it was Hartley who supplied the physical basis for the associations. This was the wave motions or vibrations within the nerves themselves, a speculative neurological background that has changed its pattern throughout the succeeding centuries, but has never completely disappeared. Thus says Hartley,

> Any Sensations A, B, C, etc., by being associated with one another a sufficient Number of Times, get such a Power over the corresponding Ideas a, b, c, etc., that any one of the Sensations A, when impressed alone, shall be able to excite in the Mind, b, c, etc., the Ideas of the rest.
>
> Sensations may be said to be associated together, when their impressions are either made precisely at the same instant of time, or in the contiguous successive instants. We may therefore distinguish associations into two sorts, the synchronous, and the successive. . . . It is to be observed, that in successive associations, the power of raising the ideas is only exerted according to the order in which the association is made. Thus, if the impressions A, B, C be always made in the order of the alphabet, B impressed alone will not raise A, but

[1] John Locke, *An Essay Concerning Human Understanding*, Bk. 2, Chap. XXXIII.

> C only. Agreeably to which it is easy to repeat familiar sentences in the order in which they always occur, but impossible to do it readily in an inverted one.[1]

The memory images of sensations, according to Hartley, are produced by the vibration on a small scale of nerve tissue previously stimulated more actively. Compound ideas were derived from revived sensations (memory images) which cohered to form a single product. Aristotle's three types of association—contiguity, similarity, and contrast—were reduced by Hartley to one simple physiological principle—wave motions or vibrations in the nerves.

In similar fashion, David Hume (1711-1776) was dissatisfied with Aristotle's trinity of laws and substituted *cause and effect* in place of contrast. However, he retained association by resemblance and by contiguity in time and place. Regarding cause and effect, he wrote: "There is no relation, which produces a stronger connexion in fancy, and makes one idea more readily recall another, than the relation of cause and effect betwixt their objects."[2] Hume also introduced the idea of the stream of consciousness which, later, became the core of the psychological doctrine of William James. He also noted that the association in cause and effect may be carried on by a common third or fourth object to which the original pair are both related, but that with each remove the association is weakened. "Cousins in the fourth degree are connected by *causation,* if I may be allowed to use that term; but not so closely as brothers, much less as child and parent. In general we may observe, that all the relations of blood depend upon cause and effect, and are esteemed near or remote, according to the number of connecting causes interpos'd betwixt the persons."[3]

With James Mill (1773-1836) the doctrine of association receives its clearest exposition. During our waking moments we are continually receiving sensations of the eye, the ear, and so forth. After these sensations, ideas are perpetually excited of sensations formerly received; after those ideas, other ideas. Thought succeeds thought, idea follows idea incessantly. Sensations do not enter into association, but the ideas and thoughts they arouse are capable of association. Aristotle's laws are reduced to the single law of contiguity. But contiguous associations

[1] David Hartley, *Observations on Man, His Frame, His Duty, and His Expectations.* Chap. I, Sec. II, Prop. X, pp. 41-42.

[2] David Hume, *A Treatise on Human Nature,* Bk. I, Part I, Sec. IV, p. 11.

[3] Ibid., p. 12.

are of two kinds—the *synchronous* and the *successive*. Successive associations, as in the Lord's Prayer, are by far the more numerous.

"Our ideas spring up, or exist," says Mill, "in the order in which the sensations existed, of which they are the copies. This is the general law of the 'Association of Ideas', by which term, let it be remembered, nothing is here meant to be expressed, but the order of occurrence. . . . The causes of strength in association seem all to be resolvable into two; the *vividness* of the associated feelings; and the *frequency* of the association." [1]

The teachings of James Mill regarding association were carried on by his son, John Stuart (1806-1873), who wielded an even more trenchant pen than his father. (See his *System of Logic* and *An Examination of Sir William Hamilton's Philosophy*.) John Stuart Mill, however, revived the principle of *similarity* after its banishment by his father.

James Mill got his "vividness" and "frequency" from the writings of a slightly younger contemporary, Thomas Brown (1778-1820), who, in his *Lectures on the Philosophy of the Human Mind*, posited nine secondary laws of association which have been summarized by Warren as follows:

(1) The relative *duration* of the original sensations: "The longer we dwell on objects, the more fully do we rely on our future remembrance of them."

(2) Their relative *liveliness:* "The parts of a train appear to be more closely and firmly associated as the original feelings have been more lively."

(3) Relative *frequency:* "The parts of any train are more readily suggested in proportion as they have been more frequently renewed."

(4) Relative *recency:* "Events which happened a few hours before are remembered when there is a total forgetfulness of what happened a few days before."

(5) Their coexistence in the past with *fewer alternative associates:* "The song which we have never heard but from one person can scarcely be heard again by us without recalling that person to our memory."

(6) *Constitutional differences* between individuals modify the primary laws: They give "greater proportional vigor to one set of tendencies of suggestion than to another."

(7) *Variations* in the *same individual,* "according to the varying emotion of the hour."

(8) "Temporary *diversities of state*" as in intoxication, delirium, or ill-health.

[1] James Mill, *Analysis of the Phenomena of the Human Mind,* Vol. I, Chap. III, pp. 70-88.

(9) Prior *habits of life* and thought—the influence of inground tendencies upon any given situation, however new or irrelevant the experience may be.[1]

When the present writer, thirty years ago, and just after graduate work with Thorndike, wrote his *Mental and Physical Life of School Children,* he little realized as he wrote about the factors involved in association—frequency, recency, vividness, primacy, resultant satisfaction, mood of the moment, relationship existing between the objects—how much he was unconsciously appropriating from the writing of Thomas Brown.

From the standpoint of connectionism no person is quite so important as Alexander Bain (1818-1903), for there is abundant evidence that he had a special appeal for both James and Thorndike. More directly than from any other writer, connectionism got its tenets and principles from Bain, who, like Hartley, was not afraid to speculate regarding the neurological background of associations. Thus the biological and physiological background that connectionism so freely uses in the explanation of behavior can be traced to Bain and to Spencer. From Bain it got trial-and-error learning, reflexes and instincts as the bases of habits, individual differences, the pleasure-pain principle in learning, and so forth. But some of these must be reserved for later sections. Here we are mainly concerned with associationism as it was exhibited by Bain in what was practically its last flowering. His systematic psychology was embodied in two volumes—*The Senses and the Intellect* (1855) and *The Emotions and the Will* (1859). The educational applications of his psychological doctrine were embodied in *Education as a Science* (1879).

According to Bain there are two fundamental laws of association—contiguity and similarity. Contiguity is merely the recurrence of previous concurrences of actions or sensations. These actions or sensations "tend to grow together, or cohere, in such a way that, when one of them is afterwards presented to the mind, the others are apt to be brought up in idea." Similarity accounted for 'constructive association,' that is, for invention and mental creation in general. 'Compound associations' are also possible; and associations that are individually too weak to operate the revival of a past idea may succeed by acting together.

In his specific contributions to learning and habit, Bain is the im-

[1] Howard C. Warren, *A History of the Association Psychology,* p. 73. New York: Charles Scribner's Sons, 1921.

mediate forerunner of the connectionists. Bain regarded reflexes and instincts as the elements of behavior, which were elaborated into habits by exercise or repetition. Learning can be described in terms of random movements (instinctive): the retention of those movements and actions which bring pleasant results, and the elimination of those which bring unpleasant results; and fixation through repetition. Here we have the earliest statements of the connectionist laws of *readiness, effect* and *exercise*. While it is generally believed that Thorndike got his laws of learning from his experiments with animals, the writer suspects that he may have been consciously or unconsciously influenced by Bain. In Thorndike's earlier days at Teachers College, he assigned Bain's *Education as a Science* as supplementary reading for his students. Bain ever keeps his feet on the ground; he is the essence of common sense. "All pupils should be brought up to the point of plain passable writing; it is not the schoolmaster's business to carry writing to the pitch of a work of art." It was the connectionist, Thorndike, who determined objectively what 'plain passable writing' should be. "Much of the curiosity of children, and of others beside children, is a spurious article. Frequently it is a mere display of egotism, the delight in giving trouble, in being pandered to and served. Questions are put, not from the desire of rational information, but from the love of excitement." So said Bain. Thorndike put it more tersely, "Children don't usually ask questions because they want to know, but to get talk back."

Bain's maxims on habits find immortality in James's classical chapter on habit. They underwent a sea-change and also some elaboration in crossing the Atlantic, but it was on Bain's maxims that James built his famous chapter.

It would give a false impression if we attributed originality to Bain in respect to all the foregoing. Few persons are original in the sense that they make contributions that have never been thought of before. Bain drew a distinction between original nature in the form of reflexes and instincts, and the products of experience in the form of habits. But likewise so did Hobbes long before him. According to Hobbes, hunger, sex, and thirst are original nature. Fear, however, is not a blind impulse, but is dependent upon the calculation of evil results. We withdraw from an object because we perceive the pain inherent within it. The search for pleasure and the avoidance of pain are the mainsprings of social conduct and the basis for social organization. Thus we see

that much that was explicit in Bain was implicit in Hobbes, and also, it may be said, in many other writers.

One other associationist should be mentioned, Herbert Spencer (1820-1903). In his early writing on psychology, he is chiefly noted for his defense of the principle of similarity and neglect of contiguity and contrast. Later his associationism changes. Darwin published his *Origin of Species* in 1859, and when Spencer wrote his revised psychology in two volumes (1870 to 1872), 'evolutionary association' held the main position. In this revision, the associative law of frequency is made to operate phylogenetically. Thus, instincts are the actions which have proved useful to the organism and have had survival value. These useful tendencies become cumulative in successive generations till finally they blossom forth as innate and inherited instincts. Most of Spencer's later associationism might be called *evolutionism,* for it is mainly concerned with the hereditary functions of the organism. Without doubt, Spencer has had a marked influence on American psychology, chiefly through James and Thorndike and the Chicago school of functional psychology.

Even after this disquisition, we are still ignorant as to what causes ideas to associate and how it is done. Somehow or other a pattern is made out of the jig-saw pieces, or several ideas fuse together in such a way that the original elements are lost in the new product. Association is a prime fact of mental life. We could, of course, say with Herbart that ideas are dynamic and may collect like swarming bees to form an apperception mass, and that the bigger the mass the greater the chance of reaching the dome or center or focus of consciousness; but we should be merely repeating a statement that could never be either refuted or proven. Association is real, as real as anything in our mental life; but its true inwardness is still wrapt in mystery.

V. Other Backgrounds of Connectionism

If Thorndike be regarded as the king-pin of connectionism, then three main streams of influence may be found in his work. The first, that of associationism, has already been traced. Bain influenced Thorndike's teaching both directly and through James. We have noted the part that reflexes and instincts played in Bain's doctrine and the way they were incorporated into connectionism. Connectionism, however, added a third gift of nature, namely, capacity. The gifts of music, mathematics, and the like are called capacities. A man inherits them

in much the same way as he inherits his reflexes and instincts. Capacities, however, are more elaborate, more complex. They develop later in life than reflexes and instincts, and are more dependent on elaborate environmental stimulation than are the simpler, unlearned reflexes and instincts. We mostly mature or grow into reflexes and instincts, but the development of our capacities is a process of learning extending over a considerable period of time. However, the capacity must be potentially present (inherited) before it can be developed by environmental stimuli. Connectionism also got its pleasure-pain principle more directly from Bain than from other writers.

The second stream can be traced to Romanes (1848-94), Lloyd Morgan (1852-), and Wundt (1832-1920)—the primary influences of Thorndike's experiments with animals. At the time that Thorndike began his studies of animal learning at Harvard in 1896-97, books dealing with the sagacity of animals, never with their stupidity, were very numerous. People at large thought animals very much more intelligent than they have since been found to be. Even such eminent scientists as Romanes and Lloyd Morgan had attributed to animals a degree of intelligence and a power of imitation (even of judgment and reasoning) which was quite misleading. Wundt, in the second edition of his *Lectures on Human and Animal Psychology*, published in 1892 and translated into English by Creighton and Titchener, had shown the unreliability of the anecdotal material commonly accepted as evidence of animal sagacity and had urged that simpler interpretations, in terms of instinct and association, should be given the preference. As Wundt's *Lectures* was the text used by James in his advanced course in general psychology which Thorndike attended in 1895-96, it is quite probable that Thorndike's thoughts were directed to experimentation with animals by this volume. Whatever the original stimulation, it is certain that Thorndike began his animal studies in Harvard in 1896-97 by observing and recording the instinctive reactions of chicks which were hatched in an incubator installed in his lodgings. Because of the fire hazard, the incubator was removed to the basement of William James' home. As the chicks grew, experiments were devised to test their learning ability.

For experimentation on the learning ability of animals, new apparatus, new devices, new methods had to be invented. Thorndike introduced the *maze*, the *puzzle-box*, and the *signal* or *choice reaction* experiment, all of which have become standard equipment in animal

psychology and have been employed in thousands of studies since that day.

Thorndike's *Animal Intelligence*, completed in 1898 as his doctoral dissertation, not only was the starting point of animal psychology as a science, but also went far toward establishing stimulus-response as the cornerstone of psychology. It is also the source of the famous laws of learning. As these will be dealt with in a later section, it is sufficient just to mention the fact here.

The third stream of influence came through Galton and Cattell. After leaving Harvard, Thorndike continued his psychological studies under Cattell and, in fact, obtained his doctorate from Columbia. Cattell had met Galton in England and had been impressed by his originality of mind. Cattell's absorption with individual differences can be traced to his acquaintance with Galton. It was from Cattell that Thorndike got his interest in individual differences, but it was from Galton (and Pearson) that he derived his life-long interest in heredity and statistics; and heredity, individual differences, and statistics have played noble parts in the story of connectionism.

VI. The Laws of Learning

Probably the best known of the contributions that connectionism has made to educational theory and practice are the so-called laws of learning. They are not laws in the sense that Boyle's law or Newton's law of gravitation is a law, but rather are they to be regarded simply as comprehensive formulations of the rules which learning obeys.

The laws usually quoted are those given in Vol. II of Thorndike's *Educational Psychology: The Psychology of Learning* (1913). These include the three major laws: *effect, exercise* or *frequency*, and *readiness*; and the five minor laws: *multiple response; attitude, set* or *disposition; partial activity; assimilation* or *analogy;* and *associative shifting*. These laws grew out of the experiments with animals, coupled with such influences as the writings of Bain, Romanes, Lloyd Morgan, Wundt, and others, and have been modified by further experiments in which human beings acted as the subjects.[1] New elements injected into the laws of learning are *belongingness, impressiveness, polarity, identifiability, availability,* and *mental system.* This shows clearly enough that the laws are not to be regarded as a closed system, com-

[1] E. L. Thorndike, *The Fundamentals of Learning*. New York: Teachers College, Columbia University, 1932.

plete from the start, but merely as tentative summaries of our knowledge of the way in which learning takes place. They will be discarded or modified whenever experiments disclose that such is necessary or desirable.

1. The Law of Effect

The first law to emerge was the law of *effect*. Briefly stated, this law runs as follows: A modifiable bond is strengthened or weakened as satisfaction or annoyance attends its exercise. With chickens and cats, Thorndike had used as motivating agents in their behavior such original satisfiers as food and release from confinement for the hungry cat, company for the lonely chicken, and so forth. These acted as rewards for certain actions which became stamped in and learned. Thorndike really took the law of effect for granted at first, as so many before him had done. Gradually, however, it became one of his most important principles of education. In his *Educational Psychology* (1903), we learn that "the work of education is to make the outcome of desirable activities pleasurable and to inhibit their opposites by discomfort" (p. 103). In *Elements of Psychology* (1905), the principle is explicitly stated in the law of habit-formation: "Any mental state or act which in a given situation produces satisfaction becomes associated with that situation, so that when the situation recurs the act is more likely than before to recur also" (p. 103). And conversely for discomfort. The educational applications are found in *Principles of Teaching* (1906). "Put together what you wish to have go together. Reward good impulses. Conversely, keep apart what you wish to have separate. Let undesirable impulses bring discomfort" (p. 110). The law was first called the law of effect in the volume entitled *Animal Intelligence* (mostly collected researches on animal learning) which appeared in 1911, and was embodied with a slightly altered wording in the three-volume *Educational Psychology* of 1913.

Regarded by connectionists as the fundamental law of learning, the law of effect has been subject to attack from many angles. The concepts of 'satisfaction' and 'annoyance' as the hedonistic explanations of effect in learning, and the aftereffects of rewards and punishments have been specially singled out for criticism.

Yet the connectionist's hedonism has a long and honorable history. It certainly goes back to Plato, for he recognized that the seeking of pleasure and the shunning of pain are strong motives in human actions

Moderate stimulation of a sensory organ is associated with pleasure; excessive or deficient stimulation is unpleasant and confusing. Aristotle took pleasure and pain as the bases of the will. The Epicureans claimed that the ideal of life was the pursuit of pleasure. Although hedonism was practically refuted throughout the Middle Ages, the concept of pleasure-seeking was revived by Hobbes who said that man directs his own actions through expectation of pleasure and pain, and that social organization is based on these human hedonic impulses. Subsequently, the pleasure-pain principle became the central theme of utilitarianism which started with Jeremy Bentham (1748-1832). Self-interest was regarded as the basis of human action. Happiness, from the standpoint of ethics, was called the 'good,' both of society and the individual. When evolutionism arose after the publication of Darwin's *Origin of Species* (1859), the concept of pleasure-pain was made use of to explain not only human motives but also the adaptive behavior of animals. This explanation is still held by many connectionists, though many others lean towards the physiological explanations expounded by Bain, Spencer, and Baldwin (1861-1934).

The educational implications of the doctrine of hedonism can be traced to Locke, who asserted that in the training of children the hedonistic principle might be invoked through approval and disapproval. Regarding memory, he claimed that the affections are instrumental in fixing ideas in the memory; that pleasure and pain alike help in the retention of ideas. Bain [1] borrowed Locke's hedonism in regard to memory. In his discussion of the formation of habits, however, he made three assumptions which are directly related to learning, namely, (1) the spontaneity of human actions independent of environmental influences; (2) the continuance of an action that gives pleasure; and (3) the contiguous adhesion between action and feeling.[2] Human actions are not all passive and dependent on stimulations. Some begin spontaneously, and when concurring with pleasure are sustained and repeated; when bringing pain, they are stopped and avoided.

Comparing Bain with Thorndike, there is seen to be a great similarity in their doctrines. "Satisfiers" and "annoyers" are fundamental categories in Thorndike's doctrine. By a satisfying state of affairs, he means "one which the animal does nothing to avoid, often doing things which maintain or renew it. By an annoying state of af-

[1] A. Bain, *The Senses and the Intellect*, pp. 334, 556-57.

[2] A. Bain, *The Emotions and the Will*, p. 318.

fairs is meant one which the animal does nothing to preserve, often doing things which put an end to it." This is hedonism objectively defined and a definition from which introspections have been eliminated. True, he also regards satisfaction as springing from the successful functioning of neural reaction patterns, whereas annoyance is either the result of unsuccessful activity or of forced activity, but the acid test of an annoying or painful action is whether or not these actions are sought and continued when once they are in action. Again, he is prone to regard satisfiers and annoyers as causes or determinants of behavior in that they are capable of strengthening or weakening connections. No wonder that Hullfish plaintively bemoans the fact that "Thorndike is not so easily pigeon-holed." [1]

Yet nobody in his senses doubts the reality of original satisfiers and annoyers. To eat when hungry is satisfying; to eat when satiated is usually annoying. "To be with other human beings rather than alone, to be with familiar human beings rather than strange ones, to move when refreshed, to rest when tired, to be not altogether unenclosed when resting at night," are samples of original satisfiers. We can add to these almost indefinitely. We like puppies better than snakes, sweet foods rather than bitter, moderate temperatures and humidity rather than extreme temperatures and humidity, soft beds to sleep on better than hard floors, sunlight better than darkness. On the other hand, being checked in locomotion by an obstacle, being hungry, being scorned, being thwarted after an original behavior series has been started, are all original annoyers.

Why are some actions satisfying, some annoying? Bain thought that the increase or decrease of vital power is the explanation of pleasure and pain. "States of pleasure," he said, "are connected with an increase, and states of pain with an abatement, of some, or all, of the vital functions." [2] Spencer, the evolutionist, maintained that feelings of pleasure and pain are the guides of human evolution and condition the direction of human lives. While he denied the possibility of understanding the intrinsic nature of pleasure and pain, he proposed the physiological theory that actions are the discharge of energy, and that the random movements of the lower living organisms with simple

[1] H. G. Hullfish, *Aspects of Thorndike's Psychology in their Relation to Educational Theory and Practice*, p. 38. Columbus, Ohio: Ohio State University Press, 1926.

[2] A. Bain, *The Senses and the Intellect*, p. 283.

nervous structures are accompanied by diffused discharges which excite the whole body. With the development of complex nervous structure, there is, besides this diffused general excitement, a special concentrated discharge to particular muscles caused by a fortuitous success in the adaptation of the movements to the environment. This success issues in a large draught of energy which is discharged to the line of nervous communication for carrying out the movement, and this becomes a route for repetition. "A few repetitions of the fortuitous concurrence of pleasure and a certain movement, will lead to the forging of an acquired connection, under the law of Retentiveness or Contiguity, so that, at an after time, the pleasure or its idea shall evoke the proper movement at once." He supposes that this large draught of energy-discharge or heightened nervous energy is the physiological counterpart of pleasure.[1]

Few connectionists follow Bain and Spencer in their explanations. The usual one given by connectionists, though nowhere specifically by Thorndike, is the evolutionary one. What was painful in the first instance was harmful; what was pleasant or satisfying was conducive to survival. These are the first of the original satisfiers and annoyers. No animal could survive if extremes of heat and cold were not annoying in the sense that the animal avoids them. The animals that felt no discomfort in sudden changes to icy surroundings or extremes of heat have vanished from the earth; those that felt uncomfortable, and adjusted themselves accordingly, have survived. The whole gamut of satisfiers and annoyers from sex to starvation can be explained in this way. The apparent exceptions, such as intemperance with drugs and inactivity during freezing, can be satisfactorily explained. Many drugs (nicotine is an excellent example) are distasteful at first. But the superior satisfaction of showing one's manhood by smoking and of joining the social group of smokers, is enough to cause the tiro to continue. And the physiological craving caused by indulgence in the drug does the rest. In regard to freezing, it is well known that cold first leads to active exercise; only when the sweets of rest after great bodily fatigue from exercise override the annoyance or fear of freezing do we sink into bodily torpor. Undoubtedly, then, in the past, the pleasant satisfiers led to survival and perpetuation of the species, while original annoyers led to extinction, and a study of original satisfiers and an-

[1] H. Spencer, *Principles of Psychology*, Vol. I, p. 280.

noyers shows that these factors have lost little of their potency as civilization has developed.

In propounding the law of effect, Thorndike thought that the two effects—satisfiers and annoyers—were about equally potent, the one in stamping in the connection, the other in stamping it out. If a preference was indicated it was towards the side of rewards, although he explicitly asserted that rewards or satisfiers following responses increased the likelihood of repetitions of the connections so rewarded, while punishments decreased the likelihood of recurrence of the punished connection.

Thus the law stood until 1932 when further experiments extending almost over a decade and using persons as subjects were reported in *Fundamentals of Learning*. In these new experiments he tried to eliminate the weakness of most experiments on the law of effect, namely, the use of both rewards and punishments of some sort, usually in close succession and in varying proportions, which made it difficult to apportion the amount due either to the one or the other. Ten separate experiments were reported of which the following is a typical one:

alguien somebody — otherwise — goose — shell — blanch
amarillo crust — hardness — quickly — carbine — yellow

The subject is trained with vocabulary material of the sort shown above in which he responds by choosing one of the five words by underlining it. As soon as he has done so the experimenter announces *Right* or *Wrong*, the former being regarded as a reward, the latter as a punishment, and the subject proceeds to the next line. The vocabulary material is so arranged that the correct word occurs in positions 1, 2, 3, 4, and 5, counting from the left with relative frequencies of 10, 15, 20, 25, 30. The training thus connects satisfying aftereffects not only with particular words, but also with choosing a word towards the end of the line. Before and after the training, the subject was tested with vocabulary tests other than those used in the training.

As a result of six experiments of the above type, it was shown that an average improvement of +52 per cent strengthening took place by one reward of a *Right* announcement, and a weakening of −4 per cent (actually a slight strengthening in the negative direction) by one punishment consisting of a *Wrong* announcement. "So far as our results go, then, all the learning in these six experiments can and ap-

parently must be credited to the strengthening by the announcement of *Right*. There is not a particle of evidence that the announcement of *Wrong* weakened these connections enough to counterbalance the strength they gained from just occurring. The wrong connections wane in relative frequency, not because they weaken intrinsically, but because they are supplanted by the right connections" (p. 288).

Thorndike's modified position is indicated by the following quotation:

> First, a satisfying aftereffect which belongs to a connection can be relied on to strengthen the connection.
>
> Second, an annoying aftereffect under the same conditions has no such uniform weakening effect. In certain cases, known by general observation or displayed in experiments such as those of Hoge and Stocking and of Warden and Aylesworth, an annoying aftereffect does weaken the tendency which produces it.
>
> Third, when it does so, its method of action is often, perhaps always, indirect. That is, the person or animal is led by the annoying aftereffect to do something else to the situation which makes him later less likely to follow the original connection.
>
> Fourth, what he is led to do directly is often (1) either to make a native or acquired response to the particular annoyance in question (as when he responds to annoyance at a certain place by leaving that place, or to annoyance by a certain object by avoiding that object, or to annoyance in the mouth by spitting out the mouth's contents), or (2) to have an idea or other awareness of the undesirability of such and such behavior (as when he responds to a *Wrong* heard after saying that 9 x 8 are 78 by thinking *78 is not good to say for 9 x 8*).
>
> Fifth, what an animal is led to do directly by an annoyer need not make him later less likely to follow the original connection. For example, let an animal that has learned to choose exit A rather than B or C or D from a certain pen nine times out of ten because A has meant rest and food whereas B, C, and D have meant only rest, be given, the next time it enters B, a violent electric shock, producing a panic of agitation and terror. Then in later trials the animal may be so agitated and panic-stricken when put in the pen that it is as likely to go to exit B as to exit A, increasing the frequency of that error from .10 to .25.
>
> The influence upon learning of both satisfiers and annoyers depends upon what they cause the animal to be or do. A satisfier which is attached to a modifiable connection always, or almost always, causes the animal to be or do something which strengthens the connection to which the satisfier is attached; but we do not know what this

> something is. It may be to maintain relatively undisturbed the physiological basis of the connection; it may be to retain it longer than would otherwise be the case; it may be to confine it by some metabolic effect; it may be to alter it in some more mysterious way. An annoyer which is attached to a modifiable connection may cause the animal to feel fear or chagrin, jump back, run away, wince, cry, perform the same act as before but more vigorously, or whatever else is in his repertory as a response to that annoyer in that situation. But there is no evidence that it takes away strength from the physiological basis of the connection in any way comparable to the way in which a satisfying aftereffect adds strength to it.[1]

These new experiments place reward in the forefront of the picture since it is more potent than punishment. The educational implications of this particular finding are of profound significance. From now on the teacher who neglects the simple but powerful word of praise does so at his pedagogical peril. Otherwise the experiments, despite the findings on 'belongingness,' 'impressiveness,' and so forth (see VII below) leave the situation in 1932 substantially the same as it was in 1913.

But not quite. An explanation of the way 'effect' operates grew out of the 1932 experiments. The mechanism was a *confirming reaction* which is aroused by a satisfying aftereffect. The confirming reaction makes it more likely that the animal will continue or repeat the response then and there if the satisfying situation persists, and more likely to repeat the response later if the situation vanishes but subsequently recurs. The confirming reaction is the main cause of learning.

The manner in which the confirming reaction develops and operates is as follows: The confirming reaction is at first an aftereffect of the $S \rightarrow R$ situation, thus:

$$S \rightarrow R \rightarrow \text{Confirming Reaction}$$

Afterwards it functions as a force connecting and binding S to R, thus:

$$S \rightarrow \text{Confirming Reaction} \rightarrow R$$

The confirming action is independent of a pleasurable result, since pain may also set it in action provided it is close enough to the satisfier in the succession of connections. However, it must not be thought that the effect of pain or the influence of a punishment, which is an annoying aftereffect, is exactly the opposite of the effect or influence of a reward upon the bond to which it belongs and of which it is the after-

[1] E. L. Thorndike, *Fundamentals of Learning*, pp. 311-13.

effect. It does not directly, invariably, and inevitably weaken the mental connection. The influence of reward or punishment is thus seen to depend upon what it leads the person to do. The reward tends to arouse the confirming reaction and so cause the continuance or repetition of the connection. Punishment does not necessarily lead to the arousal of a tendency to discontinue the punished connection or to repeat it less often, nor does it necessarily stimulate a connection of an opposite kind. It arouses whatever original behavior or past experience has linked to that particular annoying aftereffect in those particular circumstances. This may be to run away, to scream, or to perform other useless acts. Punishments, compared with rewards, are very unreliable forces in learning. Rewards are dependable because they arouse confirming reactions.

Thorndike is inclined to believe that the confirming reaction is a reaction of the neurones themselves. It is a neuronic force of reinforcement of the original response or it is the aftereffect of the total situation response.[1]

Contrast this explanation with the one usually given, namely, that after any activity the nervous system is in a hypersensitive state and does not 'click' for some time, quite frequently for some seconds after the completion of the act. This is the reason that the effect can apparently work backward after the action is performed. I play a golf stroke; the action is completed; if the stroke is of one of the right length and in the right direction it tends to be stamped in; if it is hooked or sliced or foozled in any way it is stamped out. The selection of a stamping in or stamping out has to await knowledge as to whether the stroke was a good one or not. The delay in the 'clicking' due to the hypersensitive state of the nervous systems allows the selection to be made, with the corresponding improvement of my game.

Which explanation is the more satisfactory must be left to the reader and to time. Both are highly speculative and almost impossible to prove by experiment. Thorndike, however, is certain that aftereffects strengthen or weaken connections; as certain, for instance, as he is that learning takes place. Some of his experiments reported in *Fundamentals of Learning* seem to "prove that a satisfying aftereffect

[1] E. L. Thorndike, "A Theory of the Action of the After-effects of a Connection upon It," *Psychological Review,* XL (September, 1933), 434-39.

E. L. Thorndike, *Human Nature and the Social Order,* p. 17. New York: Macmillan Co., 1940.

of a connection can, and generally does, strengthen that connection directly, irrespective of repetitions or rehearsals or recalls of the connection and of images or other representations of the aftereffects" (p. 270).

From 1932 to the present, Thorndike and his research students have been delving more deeply into the operation of the law of effect. The experimental situations have been refined to enable a more detailed analysis to be made. Some of these experiments were collected in *The Psychology of Wants, Interests and Attitudes*, but many still repose in the journals and monographs. The best summary of them has been given by Rock, whose bibliography should be consulted.[1]

Some of the newer investigations have been designed to settle such problems as:

(1) Whether or not it is possible to learn without being aware of it, or without intending to learn.

(2) Whether the aftereffects are influenced by varying the amounts of reward and punishment.

(3) Whether or not irrelevant rewards and punishments have any influence on learning.

(4) Whether or not a delay in the giving of a reward or punishment influences the aftereffects.

(5) Whether or not the data obtained from investigations on aftereffects in the schoolroom are similar to those obtained in the psychological laboratory.

(6) Whether or not the amount of reward influences the *rate* of learning.

(7) Whether or not the law of effect operates in retained situations (that is, retained until the correct choice is made) in the same way as it does when the situation disappears after one choice has been made.

In this series of experiments by Thorndike and his pupils, the pattern of experiment used by Thorndike in his earlier investigations was adopted. A situation was presented to which any one of a specified list of responses might be made, one of which was (sometimes arbitrarily) treated as right. After the subject had selected a response he was rewarded if the response was the one designated as right and punished if the response was one designated as wrong. In some experiments, for example, Tuckman's,[2] the stimulus situation vanished im-

[1] Robert T. Rock, Jr., "Thorndike's Contributions to the Psychology of Learning," *Teachers College Record*, In Honor of E. L. Thorndike, XLI (May, 1940), 751-61.

[2] Jacob Tuckman, *The Influence of Varying Amounts of Punishment on Mental Connections*, Teachers College Contributions to Education, No. 590. New York: Teachers College, Columbia University, 1933.

mediately after the subject's choice had been made and another stimulus situation was presented; in other experiments, for example, Waits',[1] the situation was retained until the correct choice was made. In practically all experiments the subject was rewarded by money or tokens or promises of money; or was deprived of such rewards or given electric shocks when the aftereffects of punishment were under investigation. Thus, Tuckman in one of his experiments deprived his subjects of one-, two-, three-, or four-tenths of a cent for every wrong answer. In another series the statement *wrong* was accompanied by one, two, three, or four electric shocks. Even Forlano,[2] who used pupils in school as subjects, gave them 5 cents if they managed to learn 20 new spellings in the time allotted. Rock designed his experiments to obtain information in regard to the following problems:

(1) Are money rewards in addition to the statement *Right* more effective for learning than the statement alone?

(2) Are quantitatively greater rewards more effective for learning than lesser rewards?

(3) Are money penalties in addition to the statement *Wrong* more effective than the statement alone?

(4) Are greater money penalties more effective than lesser money penalties?

(5) What are the relative influences upon learning of rewards and of punishments; of the smallest rewards and of the greatest punishments?

(6) What are the influences upon learning of successive applications of the various amounts of reward and of successive applications of the various amounts of punishment? [3]

It is obviously impossible in an essay of this description to give detailed results of this extensive series of studies into the law of effect. Suffice it to say that Thorndike and his students have demonstrated that learning proceeds by the action of positive aftereffects and not by the action of negative aftereffects. This statement is true whether the subject was clearly informed about which connections were to be learned, or was unaware of them, or even when the subject had no intention of learning a particular set of connections. In regard to sys-

[1] John Virgil Waits, *The Law of Effect in the Retained Situation,* Archives of Psychology No. 208. New York: Columbia University, 1936.

[2] George Forlano, *School Learning with Various Methods of Practice and Rewards,* Teachers College Contributions to Education, No. 668. New York: Teachers College, Columbia University, 1936.

[3] Robert T. Rock, Jr., *The Influence upon Learning of the Quantitative Variation of After-Effects,* Teachers College Contributions to Education, No. 650. New York: Teachers College, Columbia University, 1935.

tematic variations in the amount of reward or punishment applied as aftereffects for specific connections, the experiments provide evidence which strengthens the conclusion that rewards act primarily by confirming in the subject, then and there, whatever response tendency was rewarded. Punishment, on the other hand, had no such demonstrable effect in reducing the response tendency, either by eliminating the punished connection or the tendency to respond in a given way. A wrong connection does more harm than subsequent correction or reward can overcome. "Start right" is a piece of pedagogical advice that is immensely strengthened by these experiments. Learning seems to be best explained as a function of rewards. In the learning situation great care should be taken to set the stage so as to be sure, or as nearly so as possible, that the pupil gets the *right* answer or solution on the *first* trial. It is bad pedagogy to allow the learner to flounder along making mistake after mistake. A right response does not usually or necessarily accrue from the punishment of a wrong response. Even in school situations, learning accomplished under the condition of an actual money reward is similar to learning in laboratory situations; it is more efficient than learning for which no reward is given. Human beings differ from the lower animals in that a promised reward is possible. The potency of a promised reward is as great as and in some cases greater than an actual reward.

Summing the results in a sentence, it seems that, from the point of view of the theory of learning, Thorndike and his associates have clearly demonstrated the plausibility and acceptability of the law of effect, particularly demonstrating the significance of the consequences of satisfaction and reward and their mental or social equivalents. So educators may now rest content in the knowledge of what the man in the street has known for thousands of years, although he never put it into words, namely, that we learn and practice those things which are pleasurable and give us satisfaction.

2. The Law of Exercise or Frequency

This law, like the law of effect, was at first almost taken for granted by Thorndike. Does not 'practice make perfect'? Yet experience shows that exercise does not always lead to perfection. Practice in sitting on a bent pin or in poking the fire with the finger never leads to perfection in the art. The law of effect has to be invoked to explain why practice does not necessarily and invariably lead to improvement. Pleasurable

reactions are stamped in; painful ones are stamped out. In terms of connectionism, repetition tends to make the bond permanent. In terms of the nervous system, exercise tends to strengthen synaptic connections. The repeated passage of a nervous impulse across a synapse breaks down the resistance. Use cements the bonds of the nervous system; disuse weakens them. Thus are habits formed or broken.

The law of *exercise* or *frequency* has two parts, *use* and *disuse*. The law of *use* is stated: When a modifiable connection is made between a situation and a response, that connection's strength is, other things being equal, increased. The law of *disuse* runs: When a modifiable connection is *not* made between a situation and a response over a length of time, that connection's strength is decreased. The phrase "other things being equal" refers mostly to the effect, the satisfyingness or annoyingness of the situation.

Watson, the behaviorist, claims that frequency and recency explain learning and that it is unnecessary to invoke the law of effect. The successful action in maze learning, for example, must occur in every series; therefore, the successful action is learned mainly through frequency.[1] Apparently, Watson did not realize that unsuccessful actions within the maze were often repeated more frequently than the final and successful one. Yet it is the successful one that is finally stamped in.

Thomson has refuted this contention of Watson's by an ingenious coin-tossing experiment in which the imaginary animal was made to turn right in the maze when heads turned up, and left when tails were up. By the law of use alone it was shown that the animal would never reach the food box. The law of effect must be invoked not only for learning by animals, but for human beings as well. Neither frequency alone, nor frequency combined with recency is adequate to explain learning.[2]

Dunlap says that the law of *use*, viz., "that a response (that is, even a single response) to a given stimulus pattern definitely increases the probability that on the recurrence of the same, or substantially the same stimulus pattern, the same, or approximately the same, response will occur," is only one of three possible postulates regarding the effect of

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[1] J. B. Watson, *Behavior: An Introduction to Comparative Psychology*, p. 61 and Chap. VII. New York: Henry Holt & Co., 1914.

[2] G. Thomson, *Instinct, Intelligence and Character*, pp. 58-64. New York: Longmans, Green & Co., 1925.

exercise. The others are: that response, in itself, has *no* effect on the probability of the same stimulus pattern producing the same response in the future; and that response *decreases* such probability. He relates how he cured himself of typewriting *hte* for *the*, by voluntarily writing *hte* for about half a page, single spaced. The effect was magical for thereafter he never found *the* misspelled in any of his subsequent typing. In other words, the law of effect worked; the wrong spelling was made so distasteful that it never appeared again.[1]

These criticisms and many others led Thorndike to investigate the problem of repetition *qua* repetition in learning. The first twenty-two experiments reported deal with the extremely fundamental question as to whether, in the process of trial-and-error learning, the originally most-frequently-occurring of the several mutually-exclusive reactions that are evoked by the stimulus situation, will become more and more dominant with continued repetition quite apart from any reward or punishment or knowledge of success or failure. The typical experimental procedure of the initial experiments was either to estimate the lengths of numerous objects of systematically varied magnitude or, while blindfolded, to attempt to draw lines of systematically varied but specified lengths. Other experiments included such procedures as responding to a signal by making a movement, or connecting numbers with words, spellings with sounds, and words with parts of words. The results as a whole and with substantial uniformity proved "that with repetitions of a situation the frequent and strong connections gain very, very little, if at all, from the weak. The most reasonable explanation of them is that the gain is zero. . . . If a certain state of affairs acts upon a man a thousand times a week for a year, he will, so far as the mere repetition of that state of affairs is concerned, probably respond no better the last week than the first."[2]

The repetition of a *situation*, while tending to make a reaction somewhat stereotyped, in and of itself, is unproductive for learning. It causes no adaptive changes and has no useful selective power. Repetition of a *connection*, that is, the situation and its particular response, results in a real though somewhat small strengthening influence. Mere repetition of a connection causes learning, but the learning is slow.

Repetition of a 'connection with belonging,' that is, repetition of a

[1] K. Dunlap, "A Revision of the Fundamental Law of Habit Formation," *Science*, LXVII (April 6, 1928), 360-61.

[2] E. L. Thorndike, *Fundamentals of Learning*, pp. 62-63.

belonging sequence, strengthens the connection even when the influence of the consequence of the connection (aftereffect) is discounted through being concealed or disguised.

Belongingness is difficult to describe but easy to illustrate. The words of a sentence belong together in a way that the terminal word of one sentence and the initial word of the next do not.

The educational significance of the findings, namely, that mere repetition of a situation has no effect on learning, that repetition of a connection has a little, but very little, effect on learning, while repetition of a situation with belonging has a considerable effect on learning, is obviously great. Best of all for learning purposes is the repetition of a connection whose effect is pleasurable, that is, a connection which is rewarded in some way.

3. The Law of Readiness

Briefly the law of readiness may be stated: When a bond is ready to act, to act gives satisfaction and not to act gives annoyance. When a bond which is not ready to act is made to act, annoyance is caused. It is obvious that this law is related to the law of effect, since both involve satisfaction and annoyance. If a conduction unit is ready and operates without interference, the resulting action is successful and satisfying. When the pathway fails to operate either as a unit or at all, the action is unsuccessful and annoying. It is equally obvious that readiness is intimately associated with the condition of the neurons of the nervous system. Thorndike says: "Successful operation can, in fact, be satisfactorily defined, and what will originally satisfy and annoy, can be safely predicted only as a characteristic of the internal behavior of the neurones." [1]

But if a certain situation starts a behavior-series, then it involves not only actual conduction along certain neurons and across certain synapses, but also the readiness of others to conduct. Hence the serial action observed not only in instinctive behavior but in learned behavior also. Behavior becomes the action of a series of reflexes. There is, however, a behavior that is not so simple, namely, that which exhibits dilemma or choice. The determinative and simple type of action of animals is replaced in man by a relatively indeterminate or labile type. This higher form of behavior is characteristically human and

[1] E. L. Thorndike, *Educational Psychology*, Vol. I, *The Original Nature of Man*, p. 125. New York: Teachers College, Columbia University, 1913.

limited to man. In such cases, Bode maintains, "the arc (reflex) is not first constructed and then used, but is constructed as the act proceeds; and this progressive organization is, in the end, what is meant by conscious behavior."[1] Most of Thorndike's treatment of readiness is of the somewhat simple reflex, ready-to-go type of behavior. Thus he says: "In listing the readiness and unreadiness which different situations produce or call into play, psychology can at present make little advance beyond what any shrewd observer can see for himself once he understands the general principles. If each behavior-series is thought of as an army sending scouts ahead, or as a train, whose arrival at any one station means the sending of signals on before whereby this switch is opened, that one closed, and the other left dependent on the size or speed or color of the train—if the sight of a small object in indirect vision is realized as a cause of remote readiness of the neurones connected with the fovea, the neurones concerned in reaching and grasping, even possibly of the neurones concerned in tasting—enough has been accomplished for our purpose."[2] He does not, however, wholly reject the alternative explanation of choice, problem, and dilemma in higher forms of learning, and so is difficult to classify. Most of his doctrine of readiness is undoubtedly mechanistic, but with many loopholes that enable him to accept, partially at least, consciousness as a determining factor in the higher forms of behavior.

VII. Modifications and Additions to the Laws of Learning

1. Thorndike's Later Experiments

Mention has been made that Thorndike's later experiments on learning, using human beings as subjects, led to a modification of the laws of exercise and effect. Numerous additions and modifications were also made and new terms—*belongingness, impressiveness, polarity, identifiability, availability,* and *mental systems*—found their way into the vocabulary of connectionism.

Belongingness—a horrible word—while difficult to define is a factor of great importance in the learning process. The various words of a sentence fit or belong together; a sequence of numbers may belong together just because they are all numbers and not anything else, but

[1] B. H. Bode, "Consciousness and Psychology," p. 238, in *Creative Intelligence*, by John Dewey et al. New York: Henry Holt & Co., 1917.

[2] E. L. Thorndike, *Educational Psychology*, Vol. I, p. 133.

some number sequences may possess more belongingness than others. Thus 2, 4, 8, 16, etc., exhibit more belongingness than 1, 3, 4, 2, 5, 11, 13, 15. The associations or bonds possessing belongingness are more readily learned and remembered than others; hence, in teaching we should try to discover the natural and learned associations which cause facts to 'hang together.' Belongingness explains why it is easier to learn prose or poetry than a list of digits or nonsense syllables. It is not unrelated to certain Gestalt doctrines, including insight.

By *impressiveness* is meant strength or intensity of a stimulus or a situation. Loud sounds are considered stronger and more impressive than less intense ones. Stimuli attended to, that is, in the focus of consciousness, are more impressive than marginal elements. *Vividness* is a possible synonym. In some experiments, using word-number paired associates such as *dinner 26, basal 83, divide 37, kiss 63,* the number of correct number associations with kiss and dinner, both impressive words, is larger than the number of associations made with basal and divide, both weak words. This may have significance for practical learning situations.

Polarity means the tendency for stimulus-response sequences to function more readily in the order they were practiced than in the opposite order. It is the unidirectional quality of mental connections. Using foreign and vernacular phrases such as *raison d'être; ohne Hast, ohne Rast; exeunt omnes; facile descensus; obiter dicta,* etc., it was shown that the ends could be supplied when the beginnings were given, more readily than the beginnings could be given when the ends were supplied; the first half evokes the second half more often than the second evokes the first. In conclusion, Thorndike states:

> In view of these facts the tendency amongst psychologists of the Gestalt school to treat most or all of the constituents of perceptions and thoughts as totals which are unitary in mystical ways, being unified by inner forces above and beyond the ordinary laws of connection-forming, seems dangerous. And the tendency amongst many psychologists to retreat to vague and weak assertions about association, such as a part of a mental fact may evoke the whole of it or that things which have been put together in the mind will tend to go together thereafter, seems ill-advised. The polarity or unidirectional quality of mental connections is a more reasonable hypothesis today than ever before.[1]

[1] E. L. Thorndike, *Fundamentals of Learning,* p. 158.

Identifiability is self-explanatory. If the connection can be easily identified it is easily learned. Some concepts such as times, numbers, weights, colors, mass, density, etc., have to be analyzed out and made identifiable before they can be profitably used by us.

Availability is the get-at-able-ness of the response. Connections are easy to form in proportion to the availability or summonableness of the response, that is, in proportion to the ability of the person to have it or make it at will. "The scientific control of connection-forming with an identifiable situation and an available response involves only the straightforward application of the laws of belonging and effect."

Thorndike contrasts *mental systems* with simple habituation. For example, if in paper and pencil association experiments, the stimulus word *dear* evoked the response *sir*, this would be regarded as a simple habit; but if it evoked *fear*, some mental system must be at work. The experiments carried out by Thorndike on this problem seem to indicate rather clearly that the great majority of associations obtained by free association techniques occur as a result of mental system rather than through simple contiguous association. Mental systems are apparently not explained by ordinary connections. This is apparently true of sensory, instinctive, customary, and transcendent systems.

Finally, as previously mentioned, the later experiments showed that rewards were more potent than punishments, whereas formerly they had been regarded as equipotent.

These modifications and additions to the laws of learning do not destroy the main fabric of the connectionist doctrine. Indeed, they illustrate one important feature of connectionism, namely, the willingness of its supporters to modify their teachings and beliefs when experimental findings are not in harmony with them.

2. Lashley's Mass Action

The synaptic theory of learning that the connectionist's laws of exercise and readiness naturally demand has been attacked by Lashley. The synaptic theory assumes that the neurons are organized into functional arcs (reflex and conditioned) of various degrees of complexity. The synaptic connections between neurons can be strengthened by exercise. The arc that is well nourished and unfatigued is usually ready for action. The arcs which reach the third or cortical level of the nervous system are concerned with what have been termed the higher

thought processes—judgment, reasoning, memory and so forth. The lower arcs are concerned with simpler functions; those of the first or spinal level, for instance, with nothing more elaborate than simple reflexes. Learning takes place by the additive elaboration of arc-patterns; retention results from changes in the internal structure of neurons, especially of the cell-bodies; and gradualness in learning is explained by the necessity of overcoming the resistance of synapses.

A corollary of this theory is that brain functions must be rather definitely localized since the neuronic paths must be definite tracts with definite end-stations in the cortex. This theory of synaptic learning has a great deal of evidence to support it. Anatomists have traced the paths from sense organs to the cortex and from the cortex to the organs of response. Certain fairly definitely localized areas of the human brain have been shown to be intimately concerned with vision, hearing, movement, and somaesthetic sensations. But there were always well-established observations which did not fit the scheme. Even data gathered in experiments on learning, which were beautifully and simply explained by decreased resistance of synapses, failed to fit this oversimplified picture.

The problem was first attacked by Franz (in 1902 and 1907), one of Lashley's teachers. He conceived the idea of teaching an animal a specific habit or trick, then extirpating a part of the cortex and noting whether or not the habit was lost, and if it was lost, whether or not it could be as easily relearned as it was learned originally. He used cats and monkeys as subjects and removed the cortex by surgery. He showed conclusively that destruction of the frontal areas led to loss of certain habits and that these may be relearned. Lesions in other areas did not lead to the loss of these habits. Long-standing habits seemed to be retained better than newly formed ones when frontal lesions were made. This seemed to point to localization of habits in the frontal association area, but it also showed nonspecialization and nonlocalization when the operated animal could be retaught the trick.

Lashley carried on, from 1917, the line of experiments begun by his teacher in 1902. Lashley, however, used the more convenient white rat for his experiments and introduced thermocautery as the method of destroying portions of the cortex in place of surgery which was previously used by Franz. He also introduced the method of accurately plotting the extent of the injuries to the cortex by securing thin parallel sections of the post-mortem brain. For almost two decades he carried

on a series of careful experiments which have become classics in their field, solving problem after problem as they presented themselves to his fertile brain. These researches have been reported in technical journals, but one important series was recorded in the only monograph that Lashley, so far, has written.[1]

In this monograph, Lashley reports that ten problems were finally selected for study. Three mazes were used to test the influence of the complexity of the problem the rat was set to solve on the degree of deterioration that was caused; a fourth maze was used in testing the permanence of the defect. For diversity of sensory components, the brightness habit and the incline box were included. Retention tests for two mazes and for the brightness habit, and a test for the case of substitution of one habit for another completed the series.

The motivating agent in the maze experiments was hunger; in the discrimination experiments the incentive was hunger plus electric shocks. Ten successive errorless trials were thought to constitute learning. The scores were computed in terms of time, trials, and errors, with trials and errors proving superior to time. His main findings were as follows:

(1) For some problems [mazes] a retardation results from injury to any part of the cortex, and for equal amounts of destruction the retardation is approximately the same. The difficulty of the problem becomes progressively greater as the magnitude of the lesion increases. The magnitude of the injury is important; the locus is not.

(2) The more complex the problem to be learned, the greater the retardation produced by any given extent of lesion. The capacity to form simple habits of sensory discrimination is not significantly reduced by cerebral lesions even when the entire sensory field is destroyed. This immunity is probably due to the relative simplicity of such habits.

(3) The capacity to retain is reduced, as is the capacity to learn.

(4) Thalamic injury reduces the learning rate of the brightness habit, while injury to the cortex has practically no effect.

From these facts Lashley draws the following inferences:

(1) The learning process and the retention of habits are not dependent upon any finely localized structural changes within the cerebral cortex. The results are incompatible with theories of learning by changes in synaptic structure, or with any theories which assume that particular neural integrations are

[1] K. S. Lashley, *Brain Mechanisms and Intelligence*. Chicago: University of Chicago Press, 1929.

dependent upon definite anatomical paths specialized for them. Integration cannot be expressed in terms of connections between specific neurons.

(2) The contribution of the different parts of a specialized area or of the whole cortex, in the case of non-localized functions, is qualitatively the same. There is not a summation of diverse functions, but a non-specialized dynamic function of the tissue as a whole.

(3) Analysis of the maze habit indicates that its formation involves processes which are characteristic of intelligent behavior. Hence the results for the rat are generalized for cerebral functions in intelligence. Data on dementia in man are suggestive of conditions similar to those found after cerebral injury in the rat.

(4) The mechanisms of integration are to be sought in the dynamic relations among the parts of the nervous system rather than in details of structural differentiation.[1]

Here is a definite challenge to the connectionist theory of learning. The connections of the brain are of a radio-like nature rather than telephonic. This view receives some support from the recently discovered Berger "brain-waves" which surge unceasingly and are caused, apparently, by the self-initiated activities of the brain cells. Lashley has recently expressed his belief that the spinal reflexes are not based upon synaptic connections, and this despite the careful work by Sherrington on spinal reflexes extending over a lifetime. But Lashley's conclusions, as he has since admitted, are probably too sweeping, and for the following reasons: He has not given sufficient weight to the stages in the evolution of the brain. The cortical area is of later evolution than the midbrain, and the cortical projections from the midbrain are comparatively recent. Destroy these projections and the midbrain is left without the steadying control of the cortex. Philip Bard has shown that the 'thalamic seat of the emotions' is controlled by the cortex, and that when this control is removed the emotional reactions become grossly exaggerated. It is also within the bounds of possibility that the lower centers may reassume their ancient functions after the cortical areas are destroyed. As a matter of fact, Lashley himself found that although cortical injuries did not disturb brightness discrimination (a very primitive form of vision), thalamic injuries did; which can only mean that the thalamic region was still functional in regard to this primitive form of vision.

Nor can we press too far the analogies between rats and men. There is an accumulation of evidence which shows that brains as they be-

[1] *Ibid.*, p. 176.

come more specialized in evolution also exhibit more definite localizations. The nervous system of man is fearfully complex and the possibilities of connections almost infinite. Although we know more about the behavior we are trying to explain by the nervous system than we know about the nervous system itself, yet nobody has been found who could behave without a brain. The nervous system is undoubtedly the basis of behavior, but whether the synaptic theory is true or not, nobody, not even Lashley, can say at present. The synaptic theory, beautifully as it explains learning, will have to be modified; but we are far from the stage when we can discard it with impunity. Educationally, the bond theory of learning, which is based on the synaptic theory, is still the most valuable for schoolroom use, and need not be discarded by teachers, even if the synaptic theory is modified beyond recognition.

VIII. The Bond Theory and Heredity

Unlike other theories of learning, connectionism lays great stress upon the 'original nature of man' and, hence, upon the study of heredity. What a man does is the result of his original nature and the forces that act upon him. Nature and nurture, heredity and environment, are the correlative factors which determine man's development and behavior. Education is a special environment designed to develop certain innate traits and tendencies within the individual, and also to kill or suppress or redirect those hereditary tendencies which cannot now be socially approved. Original nature and its modifications are explained in terms of their responses or reactions, whether through movement, thought, feeling, attitude, or disposition, and of the bonds by which these are connected with life situations. The individual, then, starts, because of his structure or constitution, with certain tendencies to respond to stimuli, but the direction of their development is determined by the educative forces to which they have been subjected. The way this process is promoted is to make some responses pleasurable and satisfying and others annoying and distasteful; but how well one learns depends only partially on the quality of the education to which one is subjected, and also partially (mainly, in fact) upon one's native abilities. Intelligence is a native trait. It is the most important single trait that man possesses, for some modicum of intelligence enters into every kind of action except the lowliest. Even personality is determined to a very considerable extent by the kind of gifts nature bestowed upon the individual in his zygote stage of existence.

In large measure, the biological background, which a knowledge of heredity necessitates, has taken the place of the anatomical background which a knowledge of the nervous system imposed. Chapters on heredity, with or without reference to the influence of environment, have taken the place of those which dealt with the gross and finer structures of the nervous system. This tendency to stress the biological background is a desirable one, for, after all, man is an animal, and if we lose sight of this fact, we are likely to make very serious educational blunders.

IX. Transfer of Training

In no field has connectionism raised more controversy than in that known as transfer of training. The problem is simple to state, but difficult to unravel. If we study or practice subject-matter A, we expect a specific improvement in A. This we call *learning*. Beyond this specific improvement, we usually find a spread of the effect of study or practice which enables us to learn B, C, or D more easily than would otherwise have been the case. This we call *transfer of training*. It is a theory which denies that learning is wholly specific in character, and emphasizes its tendency to spill over and affect other fields.

Before the days of Thorndike, educators almost 'universally believed in universal transfer.' Study in any branch of learning affected other branches directly or indirectly. Training in arithmetic not only helped algebra because arithmetical operations are needed in algebra, but arithmetic had a surplus effect, educational in character, which was poetically described as a training of the 'muscles of the mind.' The doctrine is still prevalent, and rightly so, but not in the form in which it existed at the close of the nineteenth century.

It was the report of a research by Thorndike and Woodworth entitled "The Influence of Improvement in One Mental Function upon the Efficiency of Other Functions" which proved such a bombshell. The tradition of the ages was threatened by the conclusions, which were stated in the following terms:

> Improvement in any single mental function need not improve the ability in functions commonly called by the same name. It may injure it.
>
> Improvement in any single mental function rarely brings about equal improvement in any other function, no matter how similar, for the working of every mental function-group is conditioned by the nature of the data in each particular case.

These conclusions caused great commotion. The educational world was immediately up in arms. Scores of experiments were designed to confirm or refute these findings. On the whole, their position was maintained and accepted. Studies on transfer showed that the transfer effect of training may be negative, zero, or positive, but that a positive though modest transfer may usually be expected; and that transfer effects are higher than the average when the subjects are high in intelligence and when the testing and training materials have many elements in common.

Thorndike's connectionistic explanation of transfer, namely, that transfer was due to identity of substance (matter) or identity of procedure (method) was generally accepted, although a third identity, ideal or aim, was added by Bagley. Judd's theory of conscious generalization of experience was its main and only rival for many years.

After group intelligence tests had reached a reasonably high state of validity and reliability, Thorndike returned to the problem.[1] He tried to measure the disciplinary effect of each of the high-school studies. More specifically the aim of the investigation was to measure the contributions made by the various subjects taught in high schools to the improvement of scores on an intelligence test over a period of a year. The pupils, of course, made higher scores on the average in the second test than in the first. Some of this improvement may be due to maturation, some to increasing familiarity with the tests (practice effect), but some was undoubtedly due to the studies they had pursued in the interval. As these subjects had varied, Thorndike, by first equating pupils in initial attainments and then analyzing out the contributions of each study to any improvement which was found in the final scores, could calculate the transfer effects of any given study. These transfer effects are usually positive but small, so small that he concluded the intelligence of the pupil, not the particular selection of studies, was the chief factor in the transfer. This finding, that the greater the intelligence of the pupil the greater the amount of transfer, is in accord with many others. In supporting this theory of transfer by intelligence he wrote the following illuminating paragraph, one of the best he has ever written.

[1] E. L. Thorndike, "Mental Discipline in High School Studies," *Journal of Educational Psychology*, XV (January, 1924), 1-22; (February, 1924), 83-98.

Broyler, Thorndike & Woodyard, "A Second Study of Mental Discipline in High School Studies," *Journal of Educational Psychology*, XVIII (September, 1927), 377-404.

> By any reasonable interpretation of the results, the intellectual value of studies should be determined largely by the special information, habits, interests, attitudes, and ideals which they demonstrably produce. The expectation of any large differences in general improvement of the mind from one study rather than another seems doomed to disappointment. The chief reason why good thinkers seem superficially to have been made such by having taken certain school studies, is that good thinkers have taken such studies becoming better by the inherent tendency of the good to gain more than the poor from any study. When the good thinkers studied Greek and Latin, these studies seemed to make good thinking. Now that the good thinkers study Physics and Trigonometry, these seem to make good thinkers. If the abler pupils should all study Physical Education and Dramatic Art, these subjects would seem to make good thinkers. These were, indeed, a large fraction of the program of studies for the best thinkers the world has produced, the Athenian Greeks. After positive correlation of gain with initial ability is allowed for, the balance in favor of any study is certainly not large. Disciplinary values may be real and deserve weight in the curriculum, but the weights should be reasonable.[1]

Thorndike's theory of transfer by intelligence has been harmonized by the writer with Judd's theory of transfer by generalization of experience and also with his own theory of transfer by language.

Curiously enough, the modern trend is to place more emphasis on the possibilities of transfer. The transfer effects were demonstrably so small that the connectionists advised a direct attack upon a subject rather than a dependence on a related branch for some transfer effect. In the field of Latin and English, for instance, Latin undoubtedly helps (transfers to) English, but if we wish to secure good results in English, it is more profitable to spend time on English rather than on Latin. But many teachers have been able to show that it is possible to teach Latin in such a way that its influence on English is much greater than is usually secured. This may be described as teaching specifically for transfer, the only method of teaching that is worth its salt. And with this method the connectionists are in hearty agreement.

X. Connectionism and Analysis and Selection in Learning

The stress upon analysis and selection is peculiar to connectionism. Gestalt psychology will have nothing to do with analysis. In the index

[1] E. L. Thorndike, "Mental Discipline in High School Studies," *op. cit.*, p. 98.

to Koffka's monumental *Principles of Gestalt Psychology* one looks in vain for the topic 'analysis.' Yet the Gestaltists cannot do without analysis. They break up bigger problems into smaller ones that can be more readily attacked by experimental methods and analyze their results just as any other psychologist does. What they are really attacking is the atomistic character of conditioning, connectionism, and the like. Their insistence on the whole being more than the sum of the parts, while absolutely true, has led to a shocking neglect of the parts.

Connectionism is unique in emphasizing the elements or parts. Thorndike goes so far as to maintain that a person's intelligence is represented by the sum total of the bonds he has formed; it is an additive function. And analysis is elevated in some of his writing to a law of learning. "All learning is analytic" says Thorndike, and one of his critics maintains that in practice it means that "Learning is *all* analysis." [1]

The law of analysis, according to Thorndike, runs: *"When any response has been connected with many different situations alike in the presence of one element and different in other respects, the response is thereby bound to that element so that when that element appears, even in a very different total situation, it will tend to evoke that response."*[2] Thus by analysis the presentation of four apples, four dots, four fingers, and the like, eventuates in the concept 'four' which evokes a response of its own whenever it is met with. It is by analysis also that we acquire concepts and learn the use of such things as colors, sizes, and classifications of all kinds, meanings of words, such as *molecules* and *atoms,* and of phrases, such as *cause and effect.* These habits of response are the essence of human learning.

The power of analysis in the schoolroom is shown best in subjects, such as spelling, arithmetic, algebra and the like. Thorndike has made important specific contributions in each of these branches. Who before Thorndike knew or worked on the assumption that the combination $9 + 2$ was not the same as $2 + 9$; or even that the learning of the bond $9 + 8$ did not insure that $39 + 8$ would be instantly known when first encountered? Before connectionism affected the school, fractions were

[1] G. H. Hullfish, *Aspects of Thorndike's Psychology in Their Relation to Educational Theory and Practice,* p. 66. Columbus, Ohio: Ohio State University Press, 1926.

[2] E. L. Thorndike, *Education,* p. 99. New York: Macmillan Co., 1912.

taught in one step and the pupil was expected to make the deductions necessary in solving his particular problems. The connectionist Thorndike analyzed the problem into 17 steps: (1) First comes the association of ½ of a pie, ½ of a cake, ½ of an apple . . . . to (17) which gives the information that "The terms numerator and denominator are connected with the upper and lower numbers composing a fraction."

Since this was worked out, fractions have had less terror for both the pupil and the teacher. Analysis of the problem into simple elements or bonds, and selection of a sound pedagogical order in their presentation have provided an absolutely sure and simple way of teaching and learning fractions. "Building this somewhat elaborate series of minor abilities seems to be a very roundabout way of getting knowledge of the meaning of a fraction, and is, if we take no account of what is got along with this knowledge. Taking account of the intrinsically useful habits that are built up, one might retort that the pupil gets his knowledge of the meaning of a fraction at zero cost." [1]

Everybody admits that the proof of the pudding is in the eating. If connectionism, as a theory of learning, is judged by this criterion, then it is eminently successful. The education of the English-speaking world, nay of the whole civilized world (for foreigners are forced to read the works of the Dean of Educational Psychologists) has been profoundly affected by connectionism; and affected in a beneficial way. Connectionism suits the teacher in the classroom, for it has made his lot easier. While learning may not be *all* analysis and selection, it is difficult to conceive of learning in which these elements did not play a preponderant rôle. Therefore, by the pragmatic test of success in the work-a-day world of teaching, connectionism deserves our highest respect.

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[1] E. L. Thorndike, *The Psychology of Arithmetic,* p. 57. New York: Macmillan Co., 1929.

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CHAPTER IV

CONNECTIONISM: PRESENT CONCEPTS AND INTERPRETATIONS *

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I. INTRODUCTION

The type of psychology usually referred to in this volume as *connectionism* has also been called "S-R bond psychology," "dynamic psychology," [1] stimulus-response psychology, the reaction hypothesis, and the like. Stimulus-response psychology is usually regarded as a modern development of associationism although, as Dr. Sandiford has pointed out in chapter iii, it has been developed to a point where it now has very little in common with any form of associationism in existence before 1900. Connectionism since that time has been developed in many forms, both in systematic accounts and in well-rounded applications to almost every field of life—animal behavior, advertising, business and industry, abnormal behavior, social affairs, and especially to all phases of education, from teaching spelling to formulating a general philosophy of education. In these many enterprises different workers have come out with systems, implicit or explicit, which differ greatly from each other. Some are very similar to certain forms of 'conditioning' and others in their practical implications are very close to certain views of 'organismic psychology,' such as the one sketched by Hartmann in chapter v.

It will obviously be impossible to describe all the varieties of stimulus-response psychology in this chapter. The account to be given

* The author is grateful to E. L. Thorndike for reading the manuscript of this chapter. Certain minor changes which he suggested to make the content represent his views more clearly are embodied in the chapter as it here appears. The author is grateful also to Robert L. Thorndike for reading the manuscript and for suggestions made during the preparation of the material.

[1] Introduced by R. S. Woodworth in his book by that title published in 1921. This designation is also used by Edna Heidbreder in *Seven Psychologies*, 1933.

includes the essential features of the formulations of two writers, E. L. Thorndike and R. S. Woodworth. Despite some difference in emphasis, phraseology, and organization, their basal ideas are essentially the same. They worked together at the beginning of the present century, have cultivated many fields since then, and both published well-rounded accounts in 1940. Thorndike's works during these forty years represent incredibly far-flung applications to practical situations and Woodworth's represent notably sagacious considerations of all phases of systematic psychology.

At the outset, it should be noted that the stimulus-response psychology has not been regarded by either of these men as a final or fixed or even a very rigid system of 'laws,' but rather as a framework or arrangement designed primarily for certain practical purposes. For Thorndike, one purpose has been foremost, namely, to develop an arrangement of propositions or concepts which would be of highly practical service for the guidance of the professional activities of teachers. For this purpose the concepts or 'principles' must be intelligible without being too technical, definite rather than vague, and suggestive of practical applications, even if they are not phrased as precisely as might be desired for academic uses, or if they may not be used as consistently as the strict academic theorists in psychology would like. It should be understood that a 'system' of psychology can be so formulated as to be highly satisfactory for theoretical purposes and yet not be very intelligible or sufficiently definite for professional workers. At the same time, a formulation which is valid, intelligible and highly useful to a professional group, such as teachers, may be very puzzling to the specialists in theory and be unintentionally misinterpreted by them.

During the period of forty years in which Thorndike and Woodworth have been leaders, the stimulus-response psychology has been modified from time to time as new facts and theories appeared. It has been subjected to criticism from different sources; indeed, some of these criticisms are being urged at the present time, especially by the exponents of Gestalt psychology. It seems quite clear to the present writer that many of these criticisms are based on interpretations of Thorndike and Woodworth which do not conform to the views they hold. Indeed, in many instances, such as the attack upon the 'atomistic' description of the mind, Thorndike and Woodworth themselves have long been voicing essentially the same objections to certain forms of associationism. It seems clear that there is much in common between certain

'organismic' views and the basal concepts of Thorndike and Woodworth. In particular, the writer feels that the views outlined by Hartmann in chapter v are, as far as their practical import is concerned, essentially the same as those long held by Thorndike and Woodworth. It will be the primary purpose of this chapter to justify this conviction. It is believed that the best method of doing so will be to quote freely from Thorndike and Woodworth in presenting their views and in meeting the criticisms of the organismic group, as well as to make frequent reference to Hartmann's chapter.

The reader will doubtless observe that the account of the stimulus-response theory sketched in this chapter is quite different in emphasis at many points from Sandiford's account in chapter iii. Many of the items in the latter chapter are Sandiford's own views. Quite different views, more like Hartmann's, may be held under stimulus-response, and such views, I believe, are in fact reflected in Thorndike's and Woodworth's work, especially their recent writing. At the same time, Hartmann's account differs appreciably from those of other exponents of field theory. There are so many varieties in every 'school' that some formulations of different 'schools' are more alike than the extremes within any one.

II. Stimulus, Situation, Connection, Response, and Organism

In the stimulus-response formula, such concepts as stimulus, or situation, response, connection, and organism are of prime importance. Human activities of all sorts are regarded as responses made by the human organism to situations or stimuli. It is clear that in his earliest, as in all later formulations, Thorndike considered the situation to be very complex. Thus, in 1906 he wrote in his *Principles of Teaching*, "The term stimulus [or situation] is used widely for any event which influences a person." In his *Education*, written in 1912, he said. "The situation or total state of affairs acting upon a human being would have to be defined as all the universe at the moment. . . . For, directly or indirectly, it all might count in determining his response. But for ordinary purposes it is allowable to leave out of consideration those features . . . which have no appreciable effect upon him."

Likewise the response has always been regarded as a complex, total response of the organism including all components such as "a new thought, a feeling of interest, a bodily act, any mental or bodily con-

dition resulting from the stimulus."[1] Indeed, as stated in 1913, "Ultimately, indeed, every fact in human life is a case of the coaction of all the universe except the man in question and the condition of the man in question at that instant. In taking anything short of all the universe save him and calling it the situation, we are abstracting. . . . Also in taking anything short of the rich entirety of the man at that instant as the organism, we are abstracting . . . are replacing the total effective conditions of the response by some of their main features. Such abstraction is, of course, the procedure of common sense and of science."[2]

Situation and response are regarded not only as broad and complex but also as typically unified or patterned. However, it is always pointed out that the organism rarely responds to "a situation as a gross total—unanalyzed, undefined, and, as it were, without relief."[3] Typically, "some parts are more emphatic, more in relief, gain greater possession of us, count more, are attended to more than others."[4] The response may be "pictured as an elevation above a flat plain," or "an illuminated area . . . strong in one point, but melting off into darkness." This phenomenon has been described under such phrases or "principles" as "selectivity," "selective response," "analytical response," or "law of partial activity." As Woodworth writes in 1940,

> Selectivity does not mean that each small bit of a situation is dealt with separately, nor that the motor response is confined to one muscle at a time. Combination of stimuli and co-ordination of movements are both characteristic of the organism. A combination of stimuli works together in arousing activity, and a combination of muscles executes the response.
>
> A complaint sometimes brought against the stimulus-response conception is that it is "atomistic." An atomistic psychology attempts to explain any total activity by analyzing it into its elements, and this kind of explanation is sometimes felt not to get us far in psychology. However this may be, the . . . formula is not essentially atomistic. Either S or R may be as big and complex as you like. Such a performance as lifting a heavy weight by the co-ordinated action of arms, legs and trunk is properly regarded as a single response. And such an aggregate of stimuli as is presented to the eye

[1] E. L. Thorndike, *Principles of Teaching*, p. 8. New York: A. G. Seiler, 1906.

[2] E. L. Thorndike, *Educational Psychology*, Vol. II, *The Psychology of Learning*, p. 27. New York: Teachers College, Columbia University, 1913.

[3] *Ibid.*, p. 27.

[4] E. L. Thorndike, *Elements of Psychology*. New York: A. G. Seiler, 1905.

> on looking out of the window works as a single combined stimulus when it arouses the response, "What a beautiful day!"
>
> It is characteristic of the organism to make a unified (or unitary) response to a complex stimulus or collection of stimuli. It is easier to see a person's face as a whole than to notice all the different parts of the face. It is easier to see the motion of a runner than to isolate the positions through which the motion passes.
>
> Selectivity and combination would seem to be contrary tendencies and yet both are present in every activity. In seeing the whole face as a unit you at the same time isolate it from its background. It is easier to bend all the fingers at once, as in grasping an object, than to do what the young pianist has to learn with much effort, that is, to move each finger separately. Even the motion of a single finger involves the co-ordination of several muscles. But it is also true that the combined grasping movement of all the fingers is selective, for it uses certain muscles only. Not even the big movement of lifting a heavy weight brings in all the muscles, and every muscular act is selective, unless it be the general convulsion of strychnine poisoning or some other distinctly abnormal state.[1]

These statements make it difficult to understand why certain critics assert that the stimulus-response formula does not regard the situation and response as unitary, organized or patterned, that it deals only with elements, atoms, or isolated, unrelated pinpoints, that it does not embody a concept of the 'figure-on-a-ground' type. Essentially similar concepts have been basal in the Thorndike-Woodworth views for more than forty years.

III. Bond, Connection, Tendency to Response

Another concept which appears frequently to be misunderstood is that of the 'bond' or 'connection' or 'tendency to respond.' It has been charged that this is an atomistic concept; that it refers to definite, isolated neural linkages, like telephone wires, between receptor points and particular muscles, glands, or central neural 'elements'; that it is 'neurological atomism.'

The term *connection*, bond or tendency, does not refer to any neurological concept or agent at all. It refers to a functional relation between a situation and a response. It refers to an observed phenomenon and implies no neurological correlate. It implies nothing except that there is an observed tendency for a situation to be followed by a response.

[1] R. S. Woodworth, *Psychology*, pp. 38-40. New York: Henry Holt & Co., 1940.

As Thorndike himself describes it, "That a connection $S_1 \rightarrow R_1$ exists in a certain organism means . . . simply that there is a probability greater than infinitesimal that if S_1 occurs, R_1 will occur."[1] A stimulus-response psychology could be written without any reference to the nervous system whatever.[2] While Thorndike, Woodworth, and others have attempted to translate their psychology into the neural theories prevailing at various times, their success in doing so is of no importance to the basal scheme. Stimulus-response is a psychological, not a neurological theory.

IV. Role of the Organism

During recent years there has been considerable discussion of 'organismic' versus 'mechanistic' views of learning. A popular interpretation is that the mechanistic view regards the organism as a relatively helpless victim of external forces brought to bear upon it. Stimulus-response psychology is regarded by many educators as an example of this mechanistic concept that is to be contrasted with the 'organismic' view which, by implication, regards the individual as a closer approach to the status of 'captain of his soul.' Although this contrast is largely the result of misunderstanding of theoretical discussions, due to the use of the popular rather than the technical meanings of the two terms, it seems advisable briefly to discuss the role of the organism in the stimulus-response psychology.

In the S-R psychology, the organism has been given a uniquely significant role. In the Thorndike-Woodworth conception, moreover, learning is chiefly controlled— initiated, directed, sustained—by conditions within the organism. The so-called laws of "readiness" and "effect" which Thorndike formulated in his earliest writings and which were then and are now basal in his system, made the functions of the organism matters of prime importance in education. The determining factors in behavior are the characteristics of the organism, its structure, its chemical and emotional states, its hungers and thirsts, its "drives," its "likes and dislikes," its "activities-under-way," its "goal-direction," its temporary sets and adjustments, its states of fatigue and other bodily conditions, its attitudes, interests, goals, and purposes. These conditions determine what reactions the organism will make and

[1] E. L. Thorndike, *Fundamentals of Learning*, p. 19. New York: Teachers College, Columbia University, 1932.

[2] H. L. Hollingworth, *Psychology*, is an example.

what responses will be learned, since, for Thorndike, the 'effect' of the response is the most important matter and his "law of effect" is the most vital principle of learning. The organism's most notable characteristic lies in its capacity to 'select,' accept or 'confirm' on the one hand, avoid or reject on the other. The organism, as suggested by the principle of 'varied reaction' or 'multiple response,' follows a sort of 'try-anything-once' plan, but it is most emphatically 'choosey' on second trials. Woodworth states the matter as follows: "The organism is dependent on the environment for energy (food and oxygen), for stimulation and for outlet or opportunity for action. In many ways the organism resists the forces of the environment. It participates as *a relatively independent unit*[1] in what goes on in the environment."[2]

It is at this point, I believe, that the Thorndike-Woodworth conception reveals its sharpest contrast with most 'organismic' and 'conditioned response' views. "Field theories" are best illustrated, as Hartmann says, by "examples of the unambiguous regulation of the behavior of restricted parts by the larger wholes that contain them. The solar system is a . . . beautiful instance . . . of the control of vast heavenly bodies and their movements by the 'organization' to which they belong." The planets and the tides, as he points out, have relatively little independent action; their action is accounted for by "the gravitational field." Several exponents of field theories place marked restrictions on the effect of past experience in determining conduct, and past experience itself is explained in terms of similar field forces, "closure," "least effort," etc. There can be no doubt that the Thorndike-Woodworth conception does not regard the organism's activities in its environment as analogous to the action of planets or tides in the gravitational field, nor does it regard his learning as similarly—shall we say mechanically—controlled. On the contrary, these men doubtless assume that this type of field theory, however serviceable or valid it may be in other sciences, does not suggest for the human organism the 'relatively independent' action which they believe is essential to a true description of behavior.

V. Law of Effect

The decisive role of the organism itself is indicated by the prominent place which the "law of effect" has always played in Thorndike's ac-

[1] Italics mine.

[2] R. S. Woodworth, *op. cit.*, p. 51.

counts of learning. The 'effect' of a response on the organism, whether it produces 'satisfyingness' or 'annoyingness,' whether it furthers or retards progress toward the goal, is the most important matter in the learning situation. As Thorndike conceived the problem in his early work, a question of utmost importance to the educator is to determine what "states of affairs" satisfy and what annoy. To do so, required, he believed, a searching investigation of all phases of human nature, native and acquired. Consequently, in his epoch-making three volumes on *Educational Psychology* published in 1913-15, the first volume was *The Original Nature of Man*—a book, incidentally, which deals as much with the acquired as with the original nature of man. His idea was that one must understand thoroughly the nature of the human organism before one could hope to guide the learning process in any situation, even the most academic ones.

As a result of later studies Thorndike has revised and refined this formulation of 'effect.' He found it necessary to distinguish between positive or satisfying effects and negative or annoying effects. The influence of a negative outcome (punishment, annoyer, failure, etc.) is complex, variable, and undependable. Such an outcome is likely to have little directive influence, in the sense of weakening the specific reaction or tendency which was punished. What influence it does have is in large measure indirect, depending upon what it then and there leads the individual to do as a response to the punishment. If response A leads to annoyance, the situation remains present and the individual is led by the failure of response A to try response B, and if this alternative response is successful, we may expect the connection with the response B to be strengthened at the expense of response A. But the important part of this sequence is the success of response B rather than the failure of response A.

The central role in the picture of learning falls, then, to the positive outcomes (rewards, satisfiers, successes, etc.). The effect of these involves in varying degrees an awareness of successful outcome where that has been achieved. The strengthening effect of a successful outcome may be shown by (*a*) immediate repetition of the successful response, if the situation remains present, or (*b*) a greater probability that the response will appear the next time the situation is encountered. Part of the influence of the positive outcome may be indirect, by causing the subject consciously to rehearse the association, but it also

operates directly. This direct effect is attributed to a 'confirming reaction.'

A connection which is rewarded is said to lead to a biological reënforcement, which may perhaps be thought of as like the phenomena of reënforcement of motor impulses. This confirming reaction will be aroused whenever the outcome passes a certain rather low level of satisfyingness. It appears to be practically an all-or-none affair, and additional increments of reward do not produce extra increments of reënforcement of the connection. The amount of learning is not proportional to the amount of the received satisfaction.

The confirming reaction is independent of sensory pleasures, and 'satisfaction' is not to be thought of as achieving a state of blissful, sensuous pleasure. The confirming reaction seems, rather, to issue from some want or 'drive' or purpose of the organism. The larger pattern of goals and strivings of the individual determine what results shall be experienced as satisfiers, as fitting and good in that situation and what confirming reaction shall be elicited. Though a reward need not be exactly relevant to the purpose of the individual at the time, the effectiveness of an outcome in eliciting a confirming reaction depends upon the degree of its relevance to the individual's purpose and the closeness with which the outcome is felt to 'belong' to a particular behavior. A reward strengthens primarily the connection which it follows immediately and with which it is felt to 'belong.' Its influence may spread or scatter in some degree, however, to earlier or later connections.

These are the details of Thorndike's most recent formulations. They may be—they doubtless will be—revised in detail again and again in the future, but the basal idea of the organism's own potency in influencing its own course of learning is the keystone of the Thorndike psychology of learning.

VI. Identical Elements

Another concept which has from the beginning been basal in Thorndike's stimulus-response explanation of learning is the notion of 'identical elements.' It appears to have been given interpretations very different from those held by Thorndike and Woodworth. Indeed, most of the criticisms have been directed at views which they do not hold. It is important to know what it means since it is essential to the explanation of 'transfer of training,' the spread of learning, the occurrence

of innumerable errors in response, the nature of problem solving, the development of concepts and meanings, the nature of understanding, generalization, insight, discovery and invention, and the acquisition of general habits and ideals of conduct.

First, there are a few general, practical formulations which should be noted. One is: Various things (such as the inner condition of the organism, the 'set' or purpose) being the same, "the same situation will produce the same response." Secondly, as Thorndike stated the matter in 1913, "a part or element or aspect of a situation may be prepotent in causing response . . . regardless of some or all of its accompaniments."[1] This prepotency idea of Thorndike's is similar, in its practical importance, to the "figure and ground" notion of the Gestaltists. A third principle, a corollary of the preceding, is that under different conditions in the organism (fatigue, set, purpose, etc.), the same gross total situation may seem to produce very different responses—precisely because different aspects or elements of the total situation are given prepotency by different conditions of the organism. Again, the organism plays so vital a role that deep insight into it is always essential to explain the response.

If one wishes to understand or predict an individual's response, according to this view, it is therefore necessary: (1) to study the situation —not merely the 'gross total' but the elements or aspects of it which may be prepotent; (2) to study the organism—try to determine the physical conditions, the sets, attitudes, emotions, and purposes active at the moment; (3) as far as possible, to recall the responses made previously by the individual to the same situation, especially to the various possible prepotent elements or aspects of it; and (4) to note the response made, i.e., to consider it in relation to the preceding data. In this way understanding and prediction of response and control of learning may be achieved.

Now, we must consider what is meant by identical situations and nonidentical or different situations. As a matter of physical fact no two situations are ever entirely identical. If every detail were taken into account, every situation is unique. However, situations will be found which, for certain practical, educational purposes, may be regarded as the same. Thus, we may think of the display of a flash card with the word *HAT* on it, twice in succession, as practically the same

[1] *Psychology of Learning*, 1913, p. 14. This principle was variously called the "law of partial activity," "law of piecemeal activity," "law of analysis," etc.

when the task is merely to recognize or 'read' the word, even if the teacher is in a slightly different position and different sounds arise in the corridor and a host of other details are different. A change in the form or size of the lettering or in the time of exposure might be made, however, to produce a decreasing similarity until the vital aspects are so different as to produce different responses. A series of photographs of John may provide pairs varying from practically identical likenesses to others so different that John's picture cannot be recognized or may be mistaken for one of another boy. For practical purposes, we can recognize differences in the degree of identity between two or more situations.

Admitting that situations may vary from practically 'the same' to very different, we must ask: What is meant by the 'identical elements'? By identical elements is meant anything one can perceive in the external situation. Thorndike uses such words as 'aspects,' 'features,' 'parts,' 'qualities of shape, number, color,' 'relations of space, time, likeness.' He emphasizes the importance, in determining the responses of man, of such 'subtle' factors as "elements and relations which would move the lower animals only as the component sounds and relations might move a six-year-old, destitute of musical capacity and training."[1]

'Identical elements,' as thus conceived, exist in the situations of the external world to which the organism reacts. The identity or community or common aspects of situations provide the possibility for the individual to react to two or more of them in the same way, but whether he actually does so or not depends upon whether the common factor becomes prepotent for him. Whether it becomes prepotent or not depends upon many factors or conditions in the organism such as his general intelligence, his past experiences, his repertory of insights, his present set or purpose, distractions or hints (given, for example, by a teacher), his skill in maneuvering in the situation, etc. The idea is merely this: Identical 'elements' or features are a necessary, even if not a sufficient, condition for transfer and also for insight, understanding, and generalization. In education and elsewhere it is therefore useful to study the external situations in order to note the similarities and differences among them.

Beginning at about 1900, Thorndike formulated a number of practical suggestions for improving learning by helping the learner to re-

[1] E. L. Thorndike, *Psychology of Learning*, pp. 27f.

spond to the subtler 'elements' or characteristics in the situation. For example, in 1906 he wrote (to give merely a brief summary of this discussion):

> In teaching, therefore, whenever the desired response concerns an element or aspect experienced only in complex mixtures . . . [we should] provide [certain] conditions. . . . These are:
>
> (1) Experiences of enough total facts [situations] in each of which (*a*) the element is as obtrusive as possible, as little encumbered by irrelevant detail as possible, and in which (*b*) the element's concomitants or surroundings vary.
>
> (2) The comparison of these facts with attention directed . . . especially toward the element in question.
>
> (3) The association of a convenient verbal description of the element . . . with each of its manifestations. . . .
>
> (4) Repeated practice in responding correctly to the element in new complexes.[1]

In later writings, hosts of detailed suggestions have been added, such as the value of pointing out, demonstrating, drawing diagrams, formulating explanations and definitions, using pictures, graphs, apparatus, and especially methods of arranging or organizing experiences in sequence, as in the case of studying arithmetic and science. During the last decade, he has given special attention to certain suggestions, derived by research, which he has grouped under the term "belongingness." Under this term he has grouped certain tendencies toward prepotency in response, predispositions to certain types of identical elements, which seem peculiarly characteristic of human beings. Here he has investigated and described more fully than before the effects on response and transfer or generalization of instructions given to the learner, and of habits of response previously acquired, especially of habits of using various systems and general organizations, such as those revealed by responding to a word by giving a synonym or an antonym or a class to which it belongs, or by some habituated expression of speech, such as 'yours truly.'

Despite the enormous number of illustrations Thorndike has given of the role of identical elements as a necessary consideration in educating in order to secure the widest transfer and fullest insight and understanding (not to mention effective development of motor skill, etc.), the idea is still misunderstood by certain persons. For the

[1] E. L. Thorndike, *Principles of Teaching*, pp. 133-35.

Gestaltist, 'elements' is simply a fighting word. In 1903, when it was first adopted, the word was innocuous. To the Gestaltist, 'elements' suggests an array of isolated pin points or items, and not 'structures,' 'figures,' 'relationships,' or 'patterns.' From the first, however, Thorndike has used as equivalent to 'elements' such words as 'aspects,' 'factors,' 'features,' 'relations,' and the context seems to show clearly that he refers to practically the same characteristics as do the Gestaltists. If anything, his concept is less restricted, more inclusive, and *can,* in fact, include anything as 'elements' which investigation proves to be actually operative.

Another objection to the idea of transfer based on common factors seems to rest upon an erroneous assumption that transfer should invariably take effect precisely to the extent that the situations have elements in common. This view, of course, overlooks the role of the organism and all its characteristics, intelligence, previous learnings, 'set,' attitude, etc. To regard identity in the external situation as the *sole* factor in transfer is to adopt a view completely different from Thorndike's.

Other objections to the theory are made by several persons who insist that transfer can be explained only in terms of 'generalization' or 'insight.' Judd, for example, believes that transfer takes place to the extent that experience is generalized. How well and how much the person generalizes becomes the crucial matter. The Gestaltists somewhat similarly insist that transfer depends upon 'insight.' The objection to these views is not that they are wrong, but merely that they are too vague and restricted. To say one transfers his learning when he generalizes or has insight is not saying much more than: "You generalize when you generalize." "You get transfer when you get it." We must go deeper than that. In a scientific sense, no theory of transfer is a full or final explanation, but the Thorndike formulations at least point to a number of factors, observation and study of which enable us to improve learning. His point is that study of the objective situations, scrutiny and management of them, as well as the study of the condition of the organism, is fruitful not only as a means of securing better learning, including more and better transfer, but also of achieving a better understanding of generalization or insight itself. You understand insight better by knowing what conditions in the situation and in the organism help and hinder it. To the stimulus-response psychologist, such an organismic explanation as Hartmann gives, namely,

"insight is the internally apprehended correlate of the 'closing' of an incomplete configuration," is itself a decidedly incomplete configuration.

VII. Generalization versus Drill

In recent years, a number of writers have charged, or implied, that the stimulus-response conception has little faith in, or is even antagonistic to, the role of generalization in learning. For example, Brownell, in the report of his excellent studies of arithmetic, states: "Learning is held to consist in the immediate establishment of a specific, direct connection between given stimuli such as 8 + 4 and a given response, 12. Each combination is to be learned as a separate item without relation to the facts previously learned. . . . [Such a] process of teaching becomes that of administering drill." He continues: "The reasonable course of action to adopt in teaching arithmetic would seem to be that which makes the largest possible use of children's capacity for generalization." The sound basis is one which depends not on "drill as the sole method" but on "the development of understanding of facts and processes."[1] Brownell's criticism of overemphasis on repetitive practice in arithmetic appeared in 1928 and has since been cited as being directly opposed to Thorndike's views on the subject. As a matter of fact, Brownell's statement but serves to repeat Thorndike's warnings issued nearly ten years before.[2]

Brownell and Thorndike thus seem to agree upon the importance of meaning in arithmetic. Differences occur primarily at two points: (1) the aspects of arithmetic which need to be made meaningful to the learner; and (2) the time in the course of learning when progress is intrusted to repetitive practice. To the present writer, Thorndike's major contention was essentially the same protest against meaningless drill and the same plea for developing understanding, as well as the same emphasis upon interest and practical utility. A few quotations follow:

> Arithmetic consists, not of isolated, unrelated facts, but of parts of a total system, each part of which may help to knowledge of other

[1] W. A. Brownell, *Development of Children's Number Ideas in the Primary Grades*, pp. 195-96. Supplementary Educational Monographs, No. 35. Chicago: University of Chicago, 1928.

[2] Presented as lectures since 1913; published in part in *New Methods in Arithmetic* (New York: Rand, McNally & Co., 1921) and in *The Psychology of Arithmetic* (New York: Macmillan Co., 1922).

> parts, if it is learned properly. . . . Time spent in understanding facts and thinking about them is almost always saved doubly. . . . Almost all arithmetical knowledge should be treated as an organized inter-related system.[1]
>
> As each new ability is acquired, then, we seek to have it take its place as an improvement of a thinking being, as a coöperative member of a total organization, as a soldier fighting together with others, as an element in an educated personality. Such an organization of bonds will not form itself any more than any one bond will create itself. If the elements of arithmetical ability are to act together as a total organized unified force they must be made to act together in the course of learning. What we wish to have work together we must put together and give practice in teamwork.[2]
>
> Instead of making up problems to fit the abilities given by school instruction, we should preferably modify school instruction so that arithmetical abilities will be organized into an effective total ability to meet the problems that life will offer. Still more generally, *every bond formed should be formed with due consideration of every other bond that has been or will be formed; every ability should be practiced in the most effective possible relations with other abilities.*[3]
>
> The newer pedagogy of arithmetic, then, scrutinizes every element of knowledge, every connection made in the mind of the learner, so as to choose those which provide the most instructive experiences, those which will grow together into an orderly, rational system of thinking about numbers and quantitative facts.[4]

It is difficult to see how Thorndike could have been more emphatic on this point than he is here, or than he is in his treatment of such other areas of learning as algebra, spelling, reading, sciences, and indeed, in treating all types of learning and activity. In 1906, he likewise wrote "Knowledge should be not a multitude of isolated connections, but well-ordered groups of connections, related to each other in useful ways . . . a well-ordered system whose inner relationships correspond to those of the real word. . . .[5] Later, as he studied various fields, it became increasingly apparent that he considered the organization of material both laterally and sequentially to be of greatest importance. He was aware of the intrinsic difficulty and complexity of the task of arranging

[1] E. L. Thorndike, *New Methods in Arithmetic,* pp. 58-59.

[2] E. L. Thorndike, *Psychology of Arithmetic,* p. 139.

[3] *Ibid.,* p. 140.

[4] *Ibid.,* p. 74.

[5] In his *Principles of Teaching.*

experiences to provide the greatest insight and organization on the part of the learner. For example, in his book on the *Psychology of Arithmetic* (1921) he wrote,

> Psychology offers no single, easy, royal road to discovering this dynamically best order. It can only survey the bonds, think what each demands as prerequisite and offers as future help, recommend certain orders for trial, and measure the efficiency of each order as a means of attaining the ends desired. The ingenious thought and careful experimentation of many able workers will be required for many years to come.[1]

VIII. Insight, Reasoning, and Problem Solving

The principles underlying reasoning and problem solving have already been presented. In reasoning, invention, artistic creativity, problem solving, and in simpler forms of learning of acts and skills, insight, as Hartman describes it, is of course involved. What is needed is "the action of the general laws [as sketched above] in cases where the connections are with elements of the situation rather than with gross totals, and where the connections compete and coöperate in subtle and complicated organizations." For Thorndike, insight is based on response to subtle features of a situation; it is correct insight when the proper features become prepotent and incorrect insight when the wrong features elicit responses. Insight, thus explained, is at the bottom of all forms of reasoning, thinking, problem solving, and of such skills as reading,[2] arithmetic, etc.

Insight, however, is a word which seems to be given many different meanings. For many educators, it is likely to mean a *full* understanding of a situation or principle. For this reason Thorndike has preferred to discuss his principles of response, prepotency, etc., rather than insight. It is difficult in a particular case to get people to agree on how much grasp there must be to call it 'insight.' As Woodworth writes,

> For certain situations the word *insight* is too strong. We humans, in this modern age, learn to manage automobiles and radios without having more than the vaguest insight into their mechanism. No one has complete insight into any concrete thing. If we use the word insight we should understand it to include even the most superficial

[1] E. L. Thorndike, *The Psychology of Arithmetic*, pp. 143-44.

[2] For example, see E. L. Thorndike, "Reading as Reasoning," *Journal of Educational Psychology*, VIII (June, 1917), 323-32.

observation of anything that can be used to help solve a problem. The child who "sees" that pushing the wall switch turns on the ceiling light must be allowed to have "insight" though he has not the faintest idea of the wiring or of the nature of an electric circuit. . . . Because insight usually implies some penetration into the true nature of things, we had better avoid the word.[1]

Much of the disagreement between the Gestalt psychologists and others as to whether such and such a learning achievement involved 'insight' or not was due to differences in their opinions as to how much insight there must be before you call it 'insight.'

In this connection, Woodworth made an important distinction when he wrote:

> Insight is sometimes foresight and sometimes hindsight. . . . Foresight is seeing the solution before executing it; hindsight is seeing the solution after executing it. Thus a person without foresight may manipulate a puzzle ring-on-key until it comes apart, perhaps wholly unexpectedly, but he may then see what happens as he says, "Oh, that's the way it goes."

In this particular area, there have been a number of disputes. In Thorndike's early years, for example, he seemed to be convinced that many teachers had an unjustifiable faith in their ability to give pupils 'foresight' by the use of definitions, rules, and verbal principles. He felt that the pupils learned the words like parrots and achieved more boredom than insight. He advocated, for many particular instances, giving the pupil the "principle gradually along with the actual practice in the process (and often *after* the process is used) as an explanation of why the process is and must be right. The principle is then better understood and better remembered because it concerns something that the pupil is doing and has been doing."[2] This recommendation of midsight and hindsight as well as foresight has been pounced upon as evidence that Thorndike has no confidence in insight. However sound his guesses concerning particular instances of learnings may be, it would of course be absurd to assume that his psychology in general is 'drill' psychology. He would, I am sure, have agreed in 1900 with Hartmann's statement that "no experience or stimulus is ever meaningless in the strict sense" and that "insight (of a sort) appears in every form of motor learning," and he would agree now. He would also agree now, and has for forty

[1] R. S. Woodworth, *op. cit.*, pp. 299-300.

[2] E. L. Thorndike, *New Methods in Arithmetic*, p. 45.

years insisted, as does Hartmann, that there is "imperative need of schoolmen of 'helps' or 'learning aids' for insuring the presence [of insight] where generalization and abstractions are involved." Much of his recent work, clustered under such terms as "belongingness," "identifiability," "availability," "mental systems," as well as his earlier work on the school subjects and various phases of conduct, has had precisely this purpose.

IX. Trial and Error in Learning

The stimulus-response formulations usually embody the concept of 'trial and error' in learning. Gestalt psychologists have attacked this concept as being mechanistic or statistical. To some of them trial and error seems to be conceived as the case of an organism, completely befuddled, making trials at random by mere chance until, if ever, it hits upon the right reaction 'by chance.' There is a subtle but all important difference between this notion and the concept of trial-and-error learning held by the stimulus-response phychologist. For the latter, *'trial and error'* is merely a description of the behavior observed when a man or animal attempts a rather difficult learning task. Woodworth writes,

> The minimum essentials of trial and error behavior are:
> (1) A 'set' to reach a certain goal.
> (2) Inability to see any way clear to the goal.
> (3) Exploring the situation.
> (4) Seeing or somehow finding leads, possible ways to reach the goal.
> (5) Trying these leads.
> (6) Backing off when blocked in one lead, and trying another.
> (7) Finally finding a good lead and reaching the goal.

In many types of learning, this try-and-try-again process is apparent. Trial and error has not been offered by Thorndike as an explanation of learning; it was given merely as a description. In the first place, the 'trial' has not been considered to be a 'random' response in the sense of a reaction made without adequate cause. In Thorndike's own words:

> There is no arbitrary *hocus pocus* whereby man's nature acts in an unpredictable spasm when he is confronted with a new situation. His habits do not then retire to some convenient distance while some new and mysterious entities direct his behavior. On the contrary, nowhere are the bonds acquired with old situations more surely revealed in action than when a new situation appears. . . . To any new situation man responds as he would to some situation like it, or some

> element of it. In default of any bonds with [the new situation] itself, bonds that he has acquired with situations resembling it, act.[1]

It is trial-and-error learning that Thorndike is talking about here. It is clear that he regards each response to be as definitely a reaction, determined by the nature of the individual, his previous experience, his 'set' at the moment, as is his response in any situation. There is moreover nothing 'random' or 'statistical'—nothing suggesting the operation of 'chance'—in his explanation of the fact that many 'trials' appear one after another. The 'multiple' or 'varied' responses which appear are explained as due to changes in the "attitude or set of the organism, prepotency of elements,—and the shifting of bonds by progressive changes in the situation" [2] due to changed positions, bodily conditions, and the annoying and satisfying effects of the reactions made.

Finally, in Thorndike's view, hitting finally upon the right response has nothing to do with 'chance' in a statistical sense, although the correct response is often not foreseen and is often not well understood when it is made. It may be cleared up by 'hindsight,' to repeat Woodworth's phrase, although in some cases it may be only superficially understood. As Hartmann says, "Of course, there have been 'trials' during the process; and obviously there have been errors." And to his question, "But do these customary accompaniments of learning explain the heart of learning itself?" the Thorndike and Woodworth answer is and always has been: Emphatically No! Trial-and-error learning is explained in terms of the principles which we have just outlined.

X. Drill

The preceding section will, perhaps, make fairly clear Thorndike's position on drill. A fair consideration of the main principles upon which his psychology rests will make it difficult for one to understand why he is sometimes referred to as the "Champion of Drill, Drill, Drill." One of his early slogans was "Practice does not make perfect." For Thorndike, practice, drill, experience, and reaction are necessary for learning, but they alone do not guarantee it, much less explain it.

This, of course, is not saying that one can acquire skill without 'practice' or information without experience. All psychologists are agreed on this. None, as far as I know, now advocates mere repetition, mere drill, mere experience. No system, as far as I can see, places more

[1] E. L. Thorndike, *The Psychology of Learning*, pp. 28-29.

[2] *Op. cit.*, p. 23.

emphasis on drill than any other. Some persons, as persons, may favor rather high standards of accuracy, thoroughness, and other forms of perfection in special fields of learning. Thorndike, as a person, sets a high standard for himself, certainly, and probably also for others. This, however, is largely a personal matter and in no way makes his psychology a psychology of 'drill for perfection.'

XI. Motives and Purposes

A related comment sometimes made is that Thorndike does not rate very highly the role of interest, motive, or purpose. To a close acquaintance of the man and his work, this is another utterly unintelligible statement. What, then, one asks, is the purport of the "law of readiness" and the "law of effect," which lie at the heart of his psychology—principles from which Kilpatrick developed his *Foundations of Method* (1925) in which interest, attitude, "readiness," "mind-set," and purpose are basal concepts? Let us quote a typical passage from this book before turning to the treatment of 'purpose' by the stimulus-response psychologists.

> Remember that purpose is much the same as mind-set-to-an-end. If we speak of holding an end in view and of striving to attain it, we are but describing in other terms how set and readiness work. You will recall in this connection, the little girl and her wish to get the doll. The set is a persisting tendency . . . to respond in a certain fashion. The 'effort to attain the end' is the name we give this tendency. When this response is balked by any hindrance, the tendency may be strong enough to find a path for itself through related neurones. These neurones then become ready; and if they act, the resulting acts constitute what we call the 'step' or the 'means' to attain the end in view. If they succeed in attaining the end, they give satisfaction and learning ensues.
>
> This reminds me of a passage from Thorndike:
>
> "Purposive behavior is the most important case of the influence of the attitude or set or adjustment of an organism in determining (1) what bonds shall act, and (2) which results shall satisfy."[1]

And now a few somewhat more technical passages in the more modern style may be noted. For example, the following statement is more or less typical of the stimulus-response definition of motive and purpose.

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[1] W. H. Kilpatrick, *Foundations of Method*, p. 52. New York: Macmillan Co., 1925.

> A motive is distinguished from other stimuli merely by being relatively persisting. An itch, which is the response to a skin stimulus of some sort, and hunger, which is a response to internal stimuli, are called motives because they tend to persist and also to initiate and sustain activity until the itch or hunger is removed or appeased. Whatever the stimulus which arouses the motive may be, the motive itself is a persisting activity or condition in the organism which it moves to further activity. . . . An ideal or purpose, as it is usually understood, has the character of a motive.[1]

Motives and purposes play a most prominent role in the stimulus-response psychology. Thorndike's *Original Nature of Man* and his "law of effect," and especially his "law of readiness," are evidence of this. Kilpatrick's *Foundations of Method* are based upon these principles. Woodworth regarded the role of motive or 'drive' as so important that he has termed his formulations of stimulus-response, *Dynamic Psychology*. In his book by that title, he brilliantly demonstrated the perfection with which motives, drives, purposes, etc., operate in the stimulus-response scheme. A quotation from his latest book, however, seems to be exactly what is called for here.

> Though the word 'purpose' is sometimes used so broadly as to cover any activity directed to a definite end—any form of goal-seeking —it is better reserved for cases where the individual has some foresight of the end. Foresight depends on memory, for the outcome of an act cannot be foreseen except by one who has had experience in performing similar acts and noting their results.
>
> A purpose can be defined as a goal-set with foresight of the results to be obtained. It is an idea of certain desirable or undesirable results motivating activity directed toward obtaining or avoiding those results. You can have an idea of a desirable state of affairs without acting on this idea. When you say, "I'd like to do this, or to have that," your wish is not yet a purpose, but if you go on to say, "I'll do it, I'll get it," you have adopted the wish as a purpose.
>
> Throwing or shooting at a mark affords a simple example of a purposive act. You take aim, you shoot, you watch the effect. The final stage consists in observing the results. You go through one or more preparatory stages in reaching the results. You follow a path to the goal, you take means to reach the desired end. The time-span of a purposive act, the time from start to finish, may be only a couple of seconds or may extend to years. The little child's purposive acts

[1] A. I. Gates, *Psychology for Students of Education*, p. 210. New York: Macmillan Co., 1930.

have only a short time-span which enlarges as he grows older. His time perspective, both forward and backward, becomes wider and more exact. In the midst of an elaborate planned activity, like cooking a dinner or assembling a machine, the adult has a sense of where he is in the total scheme of the operation. Evidently the planning and execution of a complicated purposive act demands good intellectual grasp as well as energy and persistence.

The purpose behind a particular act is often highly specialized. Just as a learned attitude is more specific than an unlearned drive, so a purpose is more specific than the general attitude toward a person or thing. Your friend starts up and says, "I'm going over to the bookstore to get a little pocket memorandum book," and you know that he is set to do just that thing. A large share of human behavior is directed to precise ends, often formulated beforehand in words, sometimes in mental images, sometimes in blueprints and models of various kinds.

In several respects, then, a purpose is a motive at the highest degree of development. It can be more elaborate than any other motive, it is often adjusted to the exact character of a certain environment, it may compass a long series of varied acts leading up to the goal, and it is apt to have very great motivating power.[1]

A good note on which to close this chapter is Thorndike's own candid statement about purposes and other motives:

The influences which coöperate with the situation to determine the response are as complicated, variable, purposive, and spiritual as the learners themselves are. The chief role in the drama of learning is not played by the external situations, *but by the learner*. The reason why I have said much about frequency of connections, satisfyingness of connections, identifiability of situations, availability of responses and the like, and little about the purposes or mental sets or total minds which direct and organize them is not that I belittle the latter. It is rather that the general importance of the latter is obvious. . . . So far, then, there should be no quarrel between an honest connectionist or associationist and an honest purposivist. Both equally believe that individual attitudes, adjustments, dispositions, sets, interests, and purposes work with the situations of each moment to determine what connections these shall make. . . .

What is any given set or attitude or disposition of mind made out of? More broadly, what are a person's interests and purposes made out of? Still more broadly, what is his *total mind* or *self*, or *entire*

[1] R. S. Woodworth, *Psychology* (1940 edition), pp. 396-97.

system of tendencies that may coöperate with the external situations? The answer which I must in honesty give, though aware of the difficulty which I should have in defending it, is that all these are in the last analysis made out of connections and readinesses, original or acquired, including those multitudinous connections whereby satisfyingness and annoyingness are attached to certain events in the mind.[1]

XII. Concluding Comments

In conclusion, it appears that while there are definite differences between 'organismic' and 'stimulus-response' psychology in certain underlying explanatory concepts, there is very little difference in the professional or practical implications of the 'organismic' view sketched by Hartmann in chapter v and the 'stimulus-response' view held by Thorndike and Woodworth. The writer has noted the general descriptions of learning, the role of insight, the emphasis on understanding, on organization, on practice, motivation, purpose, experience, and educational guidance given by Hartmann and finds practically all of them good stimulus-response, as well as good organismic, suggestions. He has read Hartmann's final list of twenty "broader pedagogical implications of the field theory," and finds practically all of them good stimulus-response maxims, except, of course, for possible slight differences in emphasis and in ways of rationalizing them. Where differences of emphasis appear as, for example, in the "conviction" that "present learning is *less* dependent upon previous experience and the adequacy of earlier skills and information than upon the clarity, field properties and excellence of organization of the learning material itself"—a conviction which may put too much dependence on the external "organization of the learning material" and too little on the interests, set, purposes, intelligence, etc., of the learner—both sides would doubtless agree that what we have here are opinions (while we are in a state of considerable ignorance concerning the facts) and not an irreconcilable, systematic difference. Both, I am sure, would agree that the solution will come from further research without wrecking either system.

An open-minded comparison of stimulus-response views with field theories and with various formulations of the conditioned response ideas, makes it obvious that the apparent effort of some students of education to somehow find which schemes are 'all wrong' and which are 'all right' is a pointless enterprise. When an educator declares, "I reject

[1] E. L. Thorndike, *Human Learning*, pp. 120ff. New York: Century Co., 1931.

the 'atomistic' or the 'mechanistic' conception and accept the 'organismic,' " or vice versa, he is probably merely making a display of superficial understanding of what these terms really mean. The practical differences between most of these 'systems' of psychology have been exaggerated beyond all reason. Several of them, for example, not only harmonize with, but contain many vital suggestions for further improvements of, the best and most progressive forms of education now in existence.

CHAPTER V

THE FIELD THEORY OF LEARNING AND ITS EDUCATIONAL CONSEQUENCES

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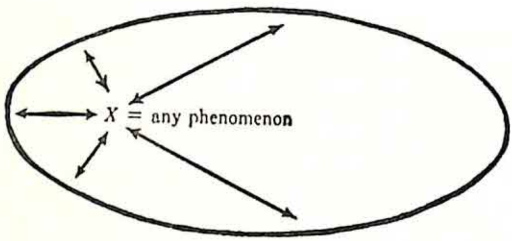
Field theory in its original and most universal meaning refers not primarily to a special system of psychology, but to a comprehensive world view that is essentially a physical philosophy of nature. Although many of the components of this thought pattern appear in the intellectual life of earlier centuries, this orientation did not mature in Europe, notably Germany, until the twentieth century and it has been effective in American psychological circles only since about 1920-25. The 'frame of reference' (itself a field concept) which it employs is unfamiliar to most laymen and teachers in the United States at present, partly because the basic ideas themselves do not merge readily with their historically established and dominant 'apperceptive' background and partly because genuine vocabulary or language and conceptual difficulties have hampered easy communication. Nevertheless, field theory in one form or another is being understood and applied by an increasing number of individuals, and, if current trends continue, by 1950 it may well be a major reference center and professional guide for a clear majority of folks in the academic and teaching worlds. Its utility in the ordinary 'conduct of life' and particularly in the improvement of pedagogical activities is not as immediately obvious as in the case of the psychological positions with which most of us are better acquainted. Moreover, it must be acknowledged that its apparent technical serviceability in many areas is not at the moment as clear or as pronounced as that of some of the older schools. This state of affairs is probably to be attributed to the need for time, opportunity, and well-equipped personnel before the applicational possibilities contained in a relatively novel system of ideas can be adequately elaborated and offered in detailed form to the great body of field workers.

The generalized notion of a 'field' within which all events occur is a commonplace in modern physics and astronomy. It has been found equally necessary and enlightening in recent biology, psychology, and sociology, considering these disciplines as representative of the whole domain of organized empirical knowledge or 'science.' *All* events in nature—and this statement plainly includes psychological and educational phenomena—*always* occur within some field, big or little, whose properties and structure explain the localized occurrence that it embraces and simultaneously permit increased control over it. The so-called *inherent* properties of an object are said to be ultimately traceable to forces impinging upon it from the surrounding field which is construed as the effective whole determining the attributes and behavior of the part or parts coming within its influence. This situation is portrayed schematically in oversimplified form in Fig. 1.



F = field or structural systems within which the phenomenon occurs.

FIGURE 1.—The basic model or diagram as used in field-theoretical discussions. The ellipse conventionally symbolizes the field or 'area' (really, 'volume') under consideration; it may be macrocosmic or microcosmic in its dimensions, but it is always 'material' in character, i.e., 'real' effective energies constitute it. The x stands for the thing, happening, or quality whose 'nature' is governed more by its *relations* to the definite circumscribed field that contains it than by any intrinsic or inherent forces. The double-headed arrows indicate that interdependence or reciprocal influence obtains between all 'parts' of the 'whole' and the total itself; actually, of course, the forces emanating from the whole are far more powerful and decisive than those coming from any of its segments. The action typified by a magnet should be analyzed afresh from this viewpoint. Advocates of field theory in educational psychology maintain that the three-fold task of any special science, viz., the understanding, prediction, and control of events, is greatly facilitated by the use of the schema here sketched. Note that the descriptive and explanatory 'units' employed by this system differ sharply from those used by associationism, connectionism, etc.

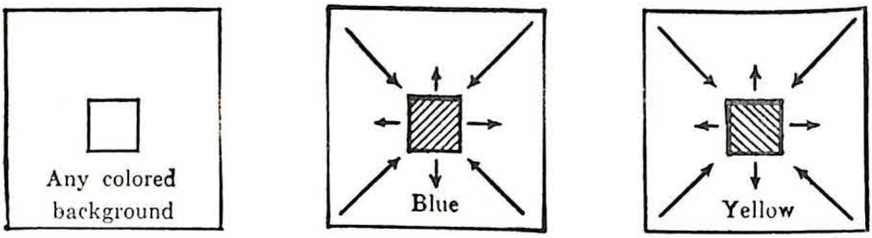
I. Illustrations of What a 'Field' Means Concretely

At this point it may be helpful to introduce a few examples of the unambiguous regulation of the behavior of restricted parts by the larger wholes that contain them.

(1) The solar system is a classic and beautiful instance of the control of vast heavenly bodies and their movements by the 'organization' to which they belong. The action of the planets is ultimately accounted for by reference to the gravitational field of the sun. Neptune, as is well known, was discovered largely because slight unaccountable perturbations and 'irregularities' of Uranus in its orbit made it necessary to postulate the existence of some remote and hitherto invisible planet within our solar system. Tides can never be explained by just searching within the ocean or even on the earth's surface alone for their 'causes'—these must be sought mainly in the fluctuating pull of the distant moon's mass upon the terrestrial mass, reënforced in a lesser degree by a similar action of the far-away sun. There are few, if any, astrophysical phenomena which can be satisfactorily interpreted without constant reference to the peculiar distribution of forces within similar extended energy fields.

(2) The living organism, whether it be man's own body or the differently patterned biological systems of such diverse creatures as the ant or the amoeba, is another impressive instance of integration and regulation of part-reactions by the total structure. The unified nature of the body compels our lips, fingers, and shoulder blades to occupy approximately the same region of space as the rest of the frame—they are forced to go along with it and to be wherever it is because, in a restricted but definite sense, they *are* it! Parts remote from the point of direct stimulation respond as much or even more than the bodily sector immediately affected; thus, under certain conditions, a person's face is altered in laughter induced by tickling the soles of his feet. A person who has lost an arm or leg will frequently refer certain 'stump' sensations to the point where the fingers or toes used to be. The temperature-regulating mechanism and the other components of the process termed 'homeostasis' by Cannon are clear examples of the drive toward symmetry, balance, and equilibrium that characterizes "the organism as a whole." Even more remarkable evidence of whole-part interlocking is revealed by ecology and appears in the adaptation that organisms (= parts) necessarily make to their specific environments (= the whole). Our mammalian-type lungs 'imply' a certain kind of atmospheric pressure and composition; the male sex organs 'fit' the female, and vice versa; and all the orifices of the body through which ingress and egress of substances occur point plainly to an 'outside' world with which the living system is in constant communication and without which it could not maintain itself

(3) In the realm of the psychological, the presence of field forces is felt on every hand as soon as one has become sensitized to their reality. If the animate and inanimate worlds are ruled by them and become intelligible to us to the degree that we apprehend their specific manifestations, then mental processes—themselves but one category of the biological—must exhibit similar operations. Indeed, the characteristic intellectual activities of man reveal these whole-part dynamics to perfection. A patch of grey paper placed on a yellow surface somewhat larger than itself will assume a bluish cast to a careful observer, but on a blue background the grey patch acquires a tannish or khaki hue. Clearly the visual or color qualities of the grey insert or 'figure' are not the result solely of the light energy contained within itself, i.e., its own apparent boundaries; more largely they result from the strong influence exerted by the different 'grounds' upon which the figure is perceived and with which significant interaction occurs. The character '1' on the standard typewriter has the same objective 'ap-



a. Simple materials for demonstration.

b. Cross-hatching indicates that a 'yellow' overlay appears upon the inner grey surface.

c. Reversed cross-hatching shows that the grey 'figure' looks bluish (or violet-ish) under these conditions. Arrows = field forces, whose estimated comparative strength is indicated by their relative length.

FIGURE 2.—Reinterpretation of the familiar phenomenon of simultaneous color contrast or 'induction,' à la field theory. Any object, say a grey square, does not remain or look 'grey' under all circumstances. Its appearance changes with the setting. The mass of the 'outfield' alters the optical properties of the 'infield.' Other forms and hues could be employed to exhibit the same principle. The reader should note, however, that other non-field theories of this phenomenon exist and he may profitably attempt to devise such explanations himself.

pearance' in the number combination of the date '1942' as in the letter combination of the word 'love,' but the sharply differing contexts or meaning conveyed by the rest of the perceptual structure of these totals give to the apparently neutral optical outline of '1' two entirely distinct functions. Seeing a man speak threateningly to a woman would ordinarily cause distress and resentment in an observer, but if the situation is a stage comedy, the altered setting with its different distribution of stresses may merely provoke mirth.

(4) Large-scale social phenomena may also be used as illustrations of the universal range of field organization. A social institution clearly is some kind of group structure which persists or recurs even though the individual human components are entirely altered with the passage of time. Societal 'fields' are conspicuously looser, less well-defined, and harder to identify than those operative in the three type-illustrations above, but it seems most improbable that the mass actions of humanity should constitute any exception to the systematic regularities found elsewhere. A family, a religious denomination, a political party, an industrial or commercial corporation, a college or university, learned societies or academies, and even great nations exhibit some, if not all, of the properties of perceptual Gestalten or configurations. A national unit, e.g., such as England, is composed today of individual members, none of whom were alive in 1800; yet the Britisher of 1942 finds his language, his religious creed, and a substantial number of other cultural 'habits' heavily conditioned by the state of affairs that prevailed in his island over a century ago. Recognizable permanence of the whole endures even amidst the many changes that take place in the 'pieces' and, inevitably, within the total itself. This 'all-or-none' character of the political state as a finite field of force (literally!) is emphasized in our day by the renewed importance of territorial boundaries, the growth of *totalitarianism* and collectivism in every country, and the obvious fact that when a nation goes to war it does so 'all over' (e.g., Yorkshire cannot refrain from going into conflict with the rest of Britain, nor Hanover when the Reich is involved in battle) just as a person's emotions seize his entire frame and are not limited either to the back of his hand or the left lung.

(5) The ordinary classroom situation is a special kind of social field and one in which the teacher usually occupies the dominant position and the pupils a subordinate one. These force or power relations are fundamental in matters of attention, discipline, and group co-

hesion. A reprimand openly delivered to one pupil usually creates some heightened tension in the entire field. The antics of the class clown or 'bad boy' serve to polarize the responses of the group as a whole upon him rather than upon the doings of the teacher. The fact that school learning takes place in a well-defined social setting means that the field forces peculiar to either democratic or autocratic systems (not necessarily to be equated with 'progressive' or 'traditional' practices, respectively) largely govern the kind of conduct the children exhibit. What is called the 'tone' of a school or grade is an emergent function of all these commonly overlooked factors of interpersonal organization.

II. Role of the 'Field' and 'Analysis' in Holistic Psychology

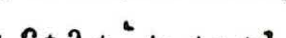
The greatest intellectual achievement of the twentieth century to date appears to be the development and demonstration of the principle of relativity in the cosmos, just as the validation of organic and inorganic evolution was undoubtedly the leading scientific triumph of the nineteenth century. In the thinking and writing of Einstein, Eddington, Jeans, and other eminent spokesmen of the 'new physics,' the terms 'field,' 'system,' 'structure,' 'organization,' 'pattern,' 'frame of reference,' etc., occur with conspicuous frequency, indicating that these conceptions are considered by these scientists to be the essential differentiating factors in the world outlook they are seeking to describe. One marked asset of a field theory of human behavior as seen by those psychologists who find this view acceptable to them is that it is more in harmony with the general spirit of contemporary natural science than those schools of psychology that have their roots in the defective premises of older historic traditions which most other areas of knowledge have either specifically repudiated or quietly outgrown. In particular, a 'field' theorist—no matter what conventional subject matter seems to be the subject of his researches—is consciously opposed to the 'atomism' or 'elementarism' which formerly prevailed in almost every discipline, largely because this latter methodology does not compare in promise or apparent fruitfulness with its ascendant rival. This circumstance explains why, in order to know 'psychology,' it is imperative to know something about 'psychologies.'

Experimental psychology in the hands of Wundt and Titchener—despite the former's admission of 'creative synthesis' and the use of other concepts in his *Völkerpsychologie*—largely rested upon the atom-

istic postulate that consciousness or mental life was reducible to (or capable of being synthesized from) minute 'sensations' initially mediated by the receptor organs. The technical reason for the emphasis upon introspection in this 'school' resided in the necessity for breaking down the larger and more extended mental states into their primitive sensory components; thus, pleasure or a condition of well-being was determined to be dependent upon, and the equivalent of, a feeling of lightness or 'brightness' in the midchest region. Although avowedly opposed to all this, behaviorism and 'conditionism' or reflexology in the hands of Watson, Pavlov, and Hull made use of the same elementaristic procedure, save that instead of 'sensations' their basic building bricks were reflexes or unconditioned responses, in keeping with the interest of these psychologists in the motor or effector processes whose importance in the psychic economy had been deliberately minimized by the sensationists who had come earlier on the scene. Associationism, the most venerable and respectable of all psychological theories, had of course been operating on essentially similar assumptions ever since its origin among the Greeks, but its emphasis was primarily upon the internal or central 'links' rather than on the two peripheral regions of the body.

To both of these trends, the younger field theory (particularly that version of it called Gestalt psychology) entered an energetic protest. It maintained that the problem of psychological analysis had been misunderstood or misapplied, and that the most appropriate unit of human behavior was some more extended action-system than either the sensation, the reflex, or the 'bond'; these latter smack of absolutism as *entities* when what is needed is a relativistic determination of the way in which energy appears to distribute itself in ourselves and in our conduct. Our motor performances have an identifiable beginning and end; our perceptions are clearly in terms of spread-out wholes or 'figures,' such as *entire* persons, objects, and events; and our 'inner life' is almost always structured, being rarely in an unstructured or nonstructured phase. Hence, it was argued, the 'units' of psychology had to be complex rather than simple (in the popular sense of these words), and natural rather than artificial.

Clearly the problem of the most suitable unit in which to describe behavior and the issue of 'analysis' are not two separate methodological questions but basically one. On this point there has been much needless misunderstanding and confusion. Obviously, field psy-

chologists, if only in order to report their researches, must 'analyze' in the ordinary meaning of that term; but it is also plain that there are different ways of analyzing, not all of them of equal merit if their consequences are considered. There is a kind of analysis, for example, which either destroys that which it examines or overlooks the more significant total or 'emergent' properties with which psychology is constantly concerned. To use the favorite word illustration of all educational psychologists: **cat** may be seen, i. e., 'analyzed,' as **c** + **a** + **t** which is the ordinary and meaningful breakdown this word receives; or, it may be analyzed in the queer distorted fashion which arbitrarily sees it as  where all the necessary pieces are found but unfortunately in utterly useless form save for purposes of illustrations like this. Indeed, the very human possibility of *any* perceptual analysis rests upon certain laws governing the reactions of the organism to which field theory in the person of Rubin first called attention in the famous figure-ground antithesis. The 'anti-analytical' approach of field psychology is easily made to seem absurd unless it is properly interpreted as the opposition of two different kinds of analysis. To recognize that *cat* shares a common rhyme or sound property with *bat* or *mat* is representative of the functional analysis preferred by the adherents of the field or 'holistic' approach, whereas the jigsaw caricature above is held to be the outcome of a dissecting process which ruins the very foundations upon which many important psychological phenomena are built. Stated differently, *post*-analytical data are something quite other than *pre*-analytical data.

Here we may profitably point out that there are specialized field *theories* in contemporary psychology rather than an undifferentiated general field theory, even though they all share a common controlling viewpoint and the likenesses so far remain much more impressive than the differences. In Fig. 3, the interrelations among these sub-systems are presented in the form in which they appear to the present writer at this stage of their development.

Let us summarize the discussion so far. A field, in modern science, "consists of a definite frame of reference marking the limits of interactions of phenomena during the occurrence of events" (Kantor). Study of these fields, which in the aggregate or, better, as an *all-inclusive* field, constitute what we call 'nature,' is primarly directed

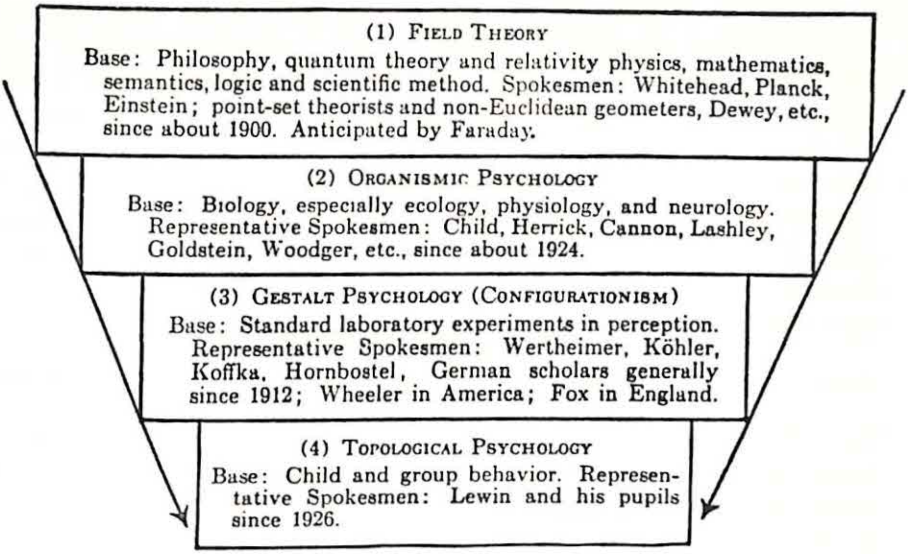


Figure 3.—An inverted pyramid indicating the relations among the major varieties of field theory as these affect psychology. The arrow symbolizes descending generality and suggests that each successive layer below the top one is related to its predecessor somewhat as a species is to a genus. The four categories used here share a common temper, but differ slightly in terminology, content emphasis, and characteristic choice of problems to be investigated. The unity of science is interestingly evidenced by the elaboration of a similar outlook (with varying degrees of success to be sure) in superficially distinct areas of inquiry: (1) is typically 'physical,' especially electromagnetic in nature; (2) is typically 'biological,' i. e., stressing the living body and its adjustments (the phrase 'organismic' psychology is incidentally a clever pedagogical device for making a strictly monistic 'bodily' or 'materialistic' psychology acceptable to teachers, most of whom appear to adhere to a traditional dualistic belief in an independent 'soul'); (3) is typically 'psychological' in its emphasis upon the representative mental or psychic life of the normal adult individual; and (4) is now typically 'sociological,' although initially concerned with issues of motivation, self, and personality that were relatively neglected by (3). Significantly, the lower or historically-later layers in the pyramid are more disposed to borrow conceptions and vocabulary from those above than vice versa.

toward the identification and patterning of the factors in mutually interbehaving systems which characteristically interact with each other as wholes and not 'bit by bit.' A person who thinks in terms of fields is like Galileo who insisted upon the dynamic relation of bodies in a field as the cause of what he witnessed in his famous experiments rather than accepting the traditional view of an *internal principle* de-

termining the fall of a body. Twentieth-century physicists now commonly view the natural order in terms of energies distributed in variously *organized systems* of masses, energies, and motions.

Some type of field formula is also congenial to those biologists who maintain that intraorganic cells are not the most suitable biological units but rather what they term "the organism as a whole." Surrounding environmental conditions (as these are effective through stimulating forces) are considered decisive in the life of an animal, although there are some organicists who "minimize the role of stimuli as exclusively antecedent elicitors of behavior and emphasize instead the spontaneous emittance of behavior." The full implications of the field position are definitely harder to establish in biology than in the inorganic world.

Oddly enough, psychology which is commonly deemed to be several shades less objective than biology, offers endless instances of the operation of field forces. Ever since Köhler wrote his *Physische Gestalten* (1920), he has aimed, apparently with considerable success, to derive his configurationist principles from a general or cosmic dynamics. The main idea seems to be that all events are structured, i. e., formed or patterned or organized in ways other than simple serial or temporal sequence. It is often protested that field theorists rely excessively and illicitly upon analogy (as in Whitehead's claim that the solar system is merely a large-scale "organism" because of the pronounced interdependence discernible *in* both the heavens and the beasts of the field), but to this objection it is retorted that Gestaltists are glad to rest their case upon 'analogy' since this is an indispensable tool in all creative or frontier thought, and that analogies are legitimate whenever they reveal genuine similarities of structure among apparently disparate phenomena. In fact, the configurationists have a distinctive interpretation of thinking itself to which we shall be introduced later in this chapter.

III. How Customary Psychological Data Are Explained by Field Theory

In order to make intelligible the wide range of behavioral phenomena which human beings exhibit, it is not enough merely to utter the magic word 'field.' At best, this provides no more than the beginning of wisdom in the intricate set of questions that always arise when

some concrete occurrence requires fundamental rather than superficial explanation. Supplementary concepts must therefore be introduced.

The reader is presumably acquainted with the 'movies.' The 'motion' that is seen on the screen is in one sense deceptive (although 'real' enough to all ordinary observers) because the movement that is perceived is merely apparent and not genuinely 'out there.' Stationary picture A is flashed on the screen for a brief moment and then succeeded after a correspondingly short passage of time by another stationary picture B, which differs from A very slightly in showing a later version of the original action or scene being photographed. *Outside* the discontinuity or break is sharp; *within* the observer, however, under optimal time and exposure conditions, nothing but smooth transitions are perceived. Many different things could be stressed here, but the one most pertinent in the light of this Yearbook's objectives is the appearance of a new whole, viz., motion, emerging from two constituent 'parts' neither of which is in motion but which, because the temperal-spatial *relations* between them are of the necessary sort, enable the brain (presumably through gradient differences between adjacent loci of higher and lower potential which lie back of the 'closure' process) to produce the appearance of motion. This phi-phenomenon, as Wertheimer first called it in 1912, is also present when an automobile driver, watching the usual traffic lights, notices a red ball apparently dropping and becoming converted into a green ball, and in other similar pairings of visual stimuli.

Another classic issue centers about the reception of visual forms and melodies. To the Gestaltist, a square is a transposable configuration because it retains its essential attribute of 'squareness' regardless of whether the length of its sides is two millimeters or two miles. The important item again is the peculiar arrangement or 'togetherness' of the parts. In the more dramatic case of a musical melody, the inner organization is even better revealed. A male voice singing *The Star-Spangled Banner* need not duplicate the pitch of a single tone which a female voice uses in singing the same song, and yet no one ever encounters any difficulties of identification or recognition in such instances. Why? Apparently what really counts here is the common 'form quality' and not the specific elements; absolute likeness among the comparable notes is less significant than their *functional equivalence* within ordered totals that are structurally alike. Certain key configurationist principles are so clearly involved in these simple examples that those who find this

orientation congenial tend to perceive the entire universe in terms of patterns that are organizationally like musical melodies (Ellis). Basically this amounts to a recognition that the apprehension of the whole is requisite before any detail can be properly interpreted—a methodological rule that seems to have considerable practical merit in education as well as in other enterprises. For example, we can recognize another's face presumably because it contains a unique *pattern* of line and color even though we are often unable to specify whether a person we know quite well has brown or blue eyes. Most of the properties of things and persons that we encounter in our experience and consider interesting and important are the attributes of similar 'extended wholes' rather than the qualities of narrowly restricted and localized parts. A square inch of skin taken from the back of the prettiest co-ed on any campus and a comparable piece from the homeliest female are practically indistinguishable because what underlies the comparative beauty of the two persons is not primarily a part property of some individual 'organ' but an attribute of the entire organism. It is only by attending to the total system that many phenomena become understandable to us.

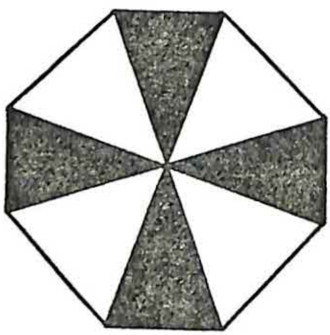


FIGURE 4.—A conventional 'reversible' figure in which normally one sees *either* a black Maltese (or German iron) cross or a white propeller. When the one is in the focus of consciousness, the other is in the margin, fringe, or 'ground' and vice versa. Important theoretically is the observation that when one design 'tumbles' or is converted subjectively into the other, this transformation occurs totally, i. e., the reaction is all of one piece since one 'arm,' angle, or side does not ordinarily change first, followed by the rest serially, but all 'tip' simultaneously. Being 'attentive' to anything means perceiving it in its 'figural' form rather than with the status of a 'ground.' Reading this text is a process of visual perception in which the black type is figure and the white page ground—both, however, must be present before the act can occur since a truly homogeneous surface could not evoke this response.

The famous figure-ground antithesis is one of the most striking instances of systemic behavior. Note again the fluctuations in the Fig. 4.

In the eyes of field psychologists, the dichotomous contrast or opposition involved in the figure-ground situation is fundamental to all experience. One cannot be actively conscious without perceiving this two-fold heterogeneity no matter what sense receptor is primarily involved. To hear a teacher's voice, a pupil must distinguish it from the other auditory stimuli which are invariably present. To 'feel' an object with the skin it is necessary to separate the boundaries of cutaneous stimulation from those areas where no contact (or a different kind of contact) occurs. In general, any sensory reaction rests upon excitation differences in nonhomogeneous fields; the contours or outlines which bound them are the places where presumably a leap of electrostatic potential appears and thus produces the differences that are found in perception.

A conspicuously impressive case of the strength of the field position appears in its application to illusions, all of which are claimed to be explainable in terms of the 'distortion' or changed appearance and meaning which parts undergo when they are included in markedly different wholes. Consider Sander's famous parallelogram illusion as drawn in Fig. 5.

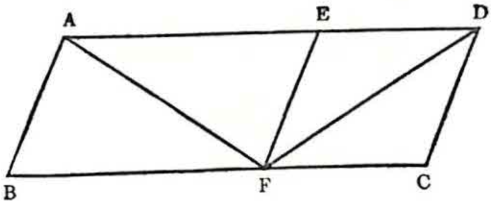


FIGURE 5.—Which of the two diagonals is longer—*DF* or *AF?* Check your impression with a ruler. You are likely to be astonished. Gestalt writers account for this by asserting that the observer is really comparing, not two straight lines, but two areas, viz., the parallelograms *ABFE* and *CDEF;* since the former is plainly a bigger magnitude *in toto,* any conspicuous part thereof like the diagonal is also 'seen' (i. e., not rationally 'inferred') as bigger than a comparable part of a smaller mass. The apparent size of an important member is overshadowed by the actual size of the whole effective field containing it; consequently the part shifts in that direction. Restructuration of the situation will either save the person from the illusory effect or markedly reduce it; e. g., if the triangle *AFD* is 'lifted' out of the complex, the two sides (= diagonals) are more correctly appraised.

An important concept much favored by the Gestaltist is the notion of "closure," a term which refers to the completional or totalizing processes released by the rest of the field. The simplest example probably appears in the test reading of an optician's eye chart at a distance slightly beyond the point of clear vision. There is a common and strong disposition to see a *C* as an *O* or an *S* as an *8*, presumably because photoelectric gradients in the retina are better balanced or discharged by these fuller and more rounded figures. Closure fits many empirical situations when but part of an indicated pattern is given, but the implied whole is speedily produced by the organism using the available 'data.' Few instances of this process are more striking than that revealed in Fig. 6, which the reader should not pass by without demonstrating the reality of this effect upon his own person, for it is one of the most dramatic concrete proofs of the immanent tendency of segregated wholes to remain wholes and to move in the direction of maximum simplicity.

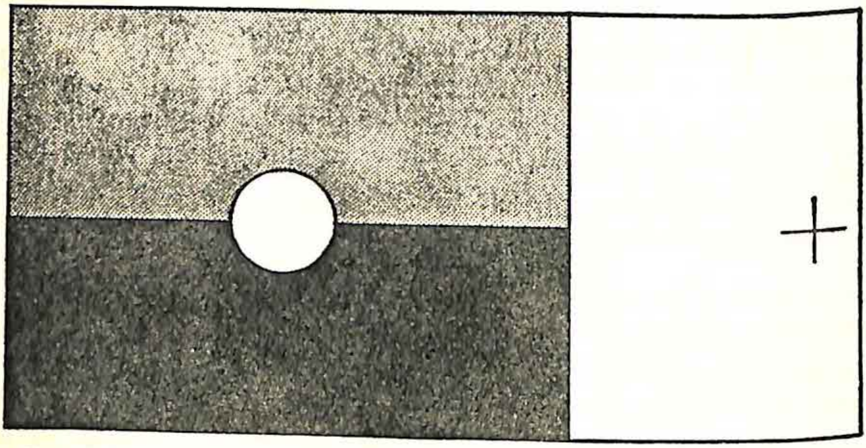


FIGURE 6.—Materials for a blind-spot experiment upon oneself. Close the left eye and fixate the right eye from a distance of *about* 6 in. upon the cross. If you are at the 'right' distance and properly oriented, the following effect is observed; the white circle disappears altogether (because it strikes the 'blind spot' in the right eye) and the black and white areas adjacent 'fill in' and divide the space evenly so that nothing but a continuous straight line border is perceived.

Objects are not thus made to disappear at the blind spot only. Fig. 7 reveals the commoner phenomenon of familiar figures that have really been 'overlearned' actually becoming 'lost' and surrendering their existential reality by being imbedded in different settings. Such

'camouflage' occurs far oftener than even the sensitized psychologist appreciates. Certainly the swastika below has been seen hundreds of times by most Europeans and Americans since 1933 and it was not wholly unfamiliar before the advent of the Nazi regime, yet few persons who look at the big square with 16 inner smaller squares beside it identify it 'spontaneously' in this linear context. The simple box figure (incidentally strongly three-dimensional in its 'free' state) vanishes utterly when obscured within the normal two-dimensional X-design at its right; indeed, many persons have great difficulty in finding it again although it actually occurs twice in the 'disguised' situation. Note too that when it is discovered, it 'pops out' suddenly as a unit and is not laboriously re-created line by line and angle by angle—a fact which argues for the presence of some unitary perceptual system corresponding to the object-drawing.

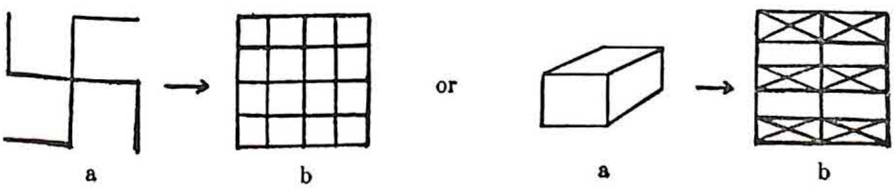


FIGURE 7.—Two noteworthy cases of the entire configuration changing the function of the parts. The contours of the *a* figures when concealed in the *b* figures outline altogether different sub-wholes and therefore lose their original character while acquiring quite new functional properties.

One final group of phenomena should be included in this section as illustrative of the more novel extensions of the organismic viewpoint in psychology. These may be grouped under the general head of "unity of the senses" in accordance with a designation first employed by Hornbostel. Although the Dane, Bartholinus, had reported as far back as 1669 that partially deaf persons could hear better in the light than in the dark and that an improvement in hearing occurred even by the dim light of a candle, no investigators prior to the emergence of the Gestalt outlook had tried to systematize the intersensory relations to which the scattered observations pointed. Psychologists had thought and acted as though the sense organs were sharply isolated from each other and that what happened in one modality was utterly independent of what transpired in the others. There is ample experimental evidence now to show that this is not the case. All the receptors appear to influence each others' activity, be it ever so slightly;

e. g., the writer has shown that visual acuity can be temporarily increased by simultaneous presentation of high or low tones and that even auxiliary tactual, pain, and olfactory stimuli have some measurable effect upon the performance of the eye. Hornbostel even isolated a common suprasensory factor which he called "brightness" as a result of his finding that most subjects were able to make meaningful equations of this sort: a gray composed of 41° white and 319° black on the color-mixer was felt or judged to be equal in 'brilliance' to both the odor of benzol and a tone of 220 vibrations per second, respectively, and these in turn were considered psychologically 'equivalent' to each other. Proven similarities of this sort have no place within an elementaristic framework which can only look upon them as bizarre, but they are easily intelligible to a system that is based upon the unitary nature of our bodies.

IV. Some Physiological Evidence for a Field Theory of Learning as Contrasted with Neurological Atomism

In what has gone before we have sought to give as concise a 'thumb-nail sketch' of the nature of field theory in psychology and other sciences and the empirical and rational bases upon which it is erected as the exigencies of a limited introduction permit. Let us emphasize again that this position is more than a psychology—it is an integrated *Weltanschauung* with which every specialty must be consistent. Similarly, the conventional chapter headings and divisions of psychology itself must be coherent with each other; it is not legitimate to adopt eclecticism as a solution to theoretical difficulties by adopting one outlook in the section on 'emotion' and another in the pages devoted to 'intelligence.' The prevailing eclectic temper in America is itself a product of mixed historical conditions, but it is the bane of our national life and either responsible for, or a rationalization of, the contradictions, inconsistencies, illogicalities, and opportunistic compromises that figure so prominently in our personal and institutional behavior. Field theory sets its face like flint against this fractionization of our intellectual life. For this reason everything that has gone before is strictly relevant to the problem of human modification because a truly organic version of behavior demands that all psychological phenomena be interpreted according to common over-arching principles—that the laws of learning and the laws of perceiving, thinking, creating,

feeling, willing, etc., must not only be harmonious one with the other but merely special instances of the *same* underlying uniformities. To the educational psychologist particularly, the loose category of 'learning' embraces so much of the total range of human conduct that what is declared to be true under this caption must be congruent with the interpretations offered under psychology in general and the various phases into which it is divided for purposes of convenience in discourse.

The picture of the physical environment and of the living organism so far presented must be supplemented by some details concerning the nervous system, which, obscure as many of the operative details may be, undoubtedly is the focus of those processes to which the term 'learning' refers. The following points may be taken as structural supports for the application of a specific field theory to the issue of modifiability.

1. Hydromedusae and other creatures less 'advanced' than ourselves possess a nervous system of a *net* type whereby total organic response to almost any 'adequate' stimulus is ensured. A satisfactory psychology must not only explain human reactions but the conduct of all other animals as well, since human psychology rightly seen in its biological frame is merely a portion of comparative psychology, even though it be the most developed because it is most interesting to man himself.

2. The autonomic nervous system, unanimously acknowledged to be more primitive than the cerebrospinal system, has a markedly diffuse field type of activity. Its postganglionic fibers are *unmyelinated* and numerous (important because myelin is known to be a good insulator). Now the grey matter of the cord and brain—the real coördinating 'centers'—is composed of many unmyelinated fibers. Since these neurones have the same structural characteristics as the conspicuously diffuse-acting postganglionic fibers, there is a strong a priori probability that they act in much the same way. The thalamus, the corpus striatum, and other 'lower' centers in the brain (archipallium) have long been held to reveal more 'diffuse' action even by those who maintained that strictly fixed pathways were typical of the cerebral cortex (neopallium).

3. The cerebellum is the master system in 'control' of muscle tonus. Note this fact: when any muscle acts, all 'contra-active' muscles must be inhibited; thus, all adjacent muscular regions of the body (such as the biceps and triceps in the upper arm) are 'active' whenever any

included part is innervated into activity. This is a field process as clearly as any natural event can be.

4. The neural mechanisms in man are known to have a chemical function. This necessarily involves the blood stream which is the principal carrier of body chemicals. These 'drugs' do not affect just one 'pathway' and that alone, but because they bathe an extended region of 'conductors' must produce a general and diffuse field action internally.

5. It is of great theoretic significance that end-processes (like recognizing a certain friend) with unique properties are not always carried by the same route in the nervous system; e. g., the *same* figure can be seen by using either foveal or peripheral vision where *different* cell 'elements' are certainly participating (von Kries and Becher). Very simply, we all know that a stranger can be introduced to us on a day when our *left* eye alone is permitted to see him, and yet we can identify him with positive assurance the next day when the *right* eye alone is active! This simple observation makes the requirement of the *rigid* 'pipe-line' type of communication favored by most forms of associationism and connectionism seem a bit absurd.

6. Lashley's extirpation experiments, while still subject to some dispute and reinterpretation, have clearly demonstrated the reality of two cerebral laws: (*a*) the principle of *mass action* declares that the cortex acts as a dynamic whole (of which a soap bubble is a simple example) since the *extent* and not the *locus* of the injury is determinative of the observed changes in the animal's behavior; (*b*) the principle of *equipotentiality* asserts that any cortical area can—after suitable recovery and retraining—assume the functions initially 'localized' in any other brain area, with the possible exception of the occipital lobes where removal results in irremediable 'psychic' blindness. [In connection with principle *a* it may be pertinent to remark that a 'circle' is the more obviously suggested by ⊂ than by ◡, presumably because 'more' is present in the C-shaped object than in the fragmentary arc. In completion tests, every teacher is aware that the difficulty of the test is roughly proportional to the *number* (i. e., 'amount') of omitted words, although *what* is omitted is also important.]

7. Highly significant is the uncontested fact that the preneural development of gradients in the human embryo clearly involves the activity of the whole organism. In other words, before the nervous system itself even comes into being as a minute structure not yet func-

tionable, it must be differentiated out of, or emerge from, the more extended mass of tissue surrounding it. In turn, the entire nervous system then becomes the proximate or immediate effective field for the newer portions which later differentiate from it. Foetal growth (neural or otherwise) is not a matter of piling one distinct and separate building block upon another like it, but of the *emergence* of such cells, tissues, and organs from their more homogeneous predecessor structures.

8. It is all but unanimously agreed, even by theorists who differ sharply in other affairs, that 'feeling and emotion' play a fundamental role in the learning and recall of experiences both by way of facilitating or inhibiting these activities. Emotional reactions are plainly 'all-over' behavior as sensed by the organism in which they occur and as witnessed by an outsider—a sure sign of diffuse field action. Is it not a natural, defensible, and perhaps inevitable inference from this that if retention and recall are fundamentally influenced by an indubitable field process like affectivity that the various phases of memory themselves belong to the same mode of operation? Larger fields interact with smaller and so on indefinitely.

9. Finally (although this does not exhaust all the arguments favorable to the 'hypothesis'), we know that the individual neurone acts or sends its impulses in only one direction, viz., from cell-body to axon and never in the reverse flow. A strict consequence of neural atomism would then be that the relationship learned between A and B (A occurring chronologically earlier) could be recalled only in that order. But this is contrary to empirical fact since B can elicit A, thus revealing the existence of a *reverse* order. More than a *single* pathway must therefore be brought into the picture to account for an undeniable phenomenon. That the $A \rightarrow B$ sequence is usually much 'stronger' than the $B \rightarrow A$ is observationally true, but the fact that the $B \rightarrow A$ combination occurs at all, no matter how rarely, when it is physiologically impossible according to a rigid but fair application of the elementaristic theory, compels us to abandon a position not compatible with experimental findings and to turn to the broader possibilities provided by the alternative field outlook.

V. The Acquisition of Motor Skills

Having laid what we hope is a firm and broad base for a valid field theory of learning, we may move with greater confidence to an ex-

amination of the concrete instances of modifiability with which the classroom practitioner and the educator generally are intimately concerned. Improvement of the large-muscle coördinations of the body is one of the simplest organismic changes to follow closely and we may profitably begin the 'applicational' phase of this paper with such a type-case.

The phrase 'motor learning' is customarily reserved for such overt acts as penmanship, typewriting, swimming, all sports, and the countless postural and 'manual' adjustments that the human body or its members can perform. The motor aspect happens to be most prominent in these types of skill, but it should not be forgotten that the sensory and particularly the central coördinating components are absolutely necessary to the discharge of the complete act. It is always the total organism that does the learning and not just those outer mechanisms that are most conspicuously involved.

This assertion can be tested very simply by a few observations. The reader of these lines is probably a right-handed person who has rarely, if ever, signed his name with his left hand. Now take this occasion to write your signature with this left or nonpreferred hand. The name will be written more slowly, with less ease, and the attractiveness or legibility is probably less than usual; but it is nonetheless recognizable even though one may never have written the name this way more than two or three times before. It is clearly much better as a signature than that produced by the preferred hand after the same number of trials in infancy. This familiar phenomenon of 'cross-education' or transfer shows that the learning has not remained confined to the exterior points or segments primarily involved but 'irradiated' elsewhere—the total central nervous system was concerned with the original learning and was influenced by it. This may be shown still more convincingly by one's ability to write one's name in the sand at the beach using the big toe as a stylus, by trying to write any word with the elbow (by tracing in dust), by attaching a pointer to the head or body as a whole, and by the airplane pilot's stunt of sky-writing. This curious fact that an identifiable form, or transposable gestalt, can be produced in so many different ways is fairly convincing evidence that skill involves a modification of the *entire* system and not just of some of the peripheral nerve endings. 'Sensory' learning behaves in the same way, for we can all recognize the Arabic numeral *8* when traced fairly large by someone else's finger across the middle of our bare backs even though

there is nothing in common between this odd experience (which apparently requires some kind of transposition from the cutaneous domain to the visual before it can successfully occur) and earlier ones in which we have directly seen the numeral, save its characteristic 'shape.'

In the acquisition of any skill in which muscular coördination is a major factor, this role of the complete organism must be remembered and acted upon if efficient learning is to occur. The acquisition of skill in swimming shows this to perfection. The upright posture of man is apparently the prime reason why swimming is not a native or unlearned skill for him as it seems to be for most quadrupeds. Most other land animals make an immediate adjustment (one-trial learning?) upon being thrown into the water, helped, no doubt, by the fact that their posture can be kept much the same as in normal locomotion. In man the mastery of the necessary motor controls in swimming is like a delayed perceptual insight where the figure is hidden in the 'ground,' for it takes some time to grasp the 'pattern' of the swimming performance and to translate this into the appropriate sequence of separate movements. It is not enough, as everyone knows who recalls his own first efforts to swim, to breathe correctly, to hold the head and body in the right position, to kick properly, and to swing the arms in the desired fashion, if all these things are done without reference one to the other. These things must all be assembled into a working unit before the skill of swimming as a configured action really exists. The integration of these partial responses into a higher-order act which depends upon each of them but which none of them alone can bring about is the descriptive essence of every skill known to man.

The insight phenomenon also appears in every form of motor learning even though it is often disguised and less obtrusive than in other types of learning. The comparative swiftness of the final stages of some motor learning after a long and unsuccessful preliminary 'practice' period indicates that the necessary neural reorganization is indispensable to the mastery of the skill. The act cannot be done until one gets the 'feel' or 'hang' of it. Thus, one eight-year-old girl who had had several summers' swimming opportunity did not really acquire more than a feeling of tolerant familiarity with the water until she reached a lake where her father had been a camp counselor in his youth. That very day, reënforced probably by the excited interest produced by this knowledge and other favorable factors such as warm air and water

and pleasant children about, she began to swim a distance of fifty feet or so at one time with practically no instruction. She repeated this many times, and remained in the water upwards of five hours thoroughly enjoying herself. An episode of this sort is not something unusual nor is the interpretation to be buttressed solely by a dramatic anecdote. Evidently the swimming experiences of most persons conforms to this general model: Inability to swim a yard, followed in a few weeks after the primary focal learning by ability to swim almost a mile where the person's strength and physique permit. After all, the stroke combination used on the fifth occasion is not structurally very different from that used on the five-thousandth!

Differences in motivation, social and physical factors, and perhaps sheer maturation determine many details, but the broad picture is clear enough. A long period of little or no measurable headway, then a quick sharp rise followed by a slower and less spectacular gain in the learning curve—this is the type followed by skills which have an

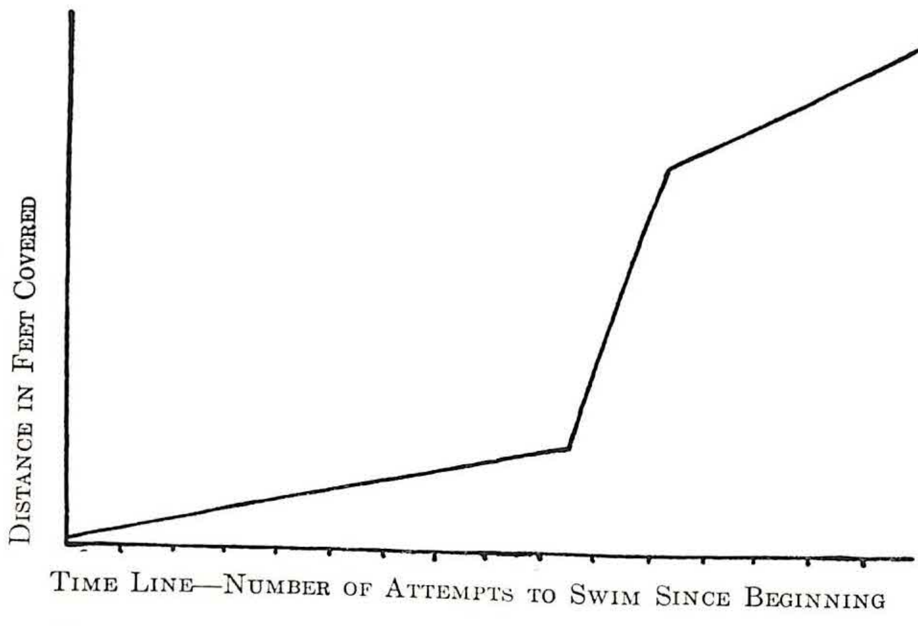


Figure 8.—Schematized individual learning curve for a motor performance like swimming or walking. For groups the angularity would disappear and a smooth serpentine S curve inflected at the same points would be substituted. (The reader should be warned that some critics of the field position hold that swimming is too favorable an example. Test this view by selecting some other case of motor learning with which you are familiar.)

all-or-nothing character. The difference between swimming and nonswimming is usually apparent to an observer, although the nonswimming stage of effort appears to be necessary to prepare the ground for the appearance of the figure.

Walking is an act which is learned by all but physically-handicapped persons so early and so uniformly that it has been called 'instinctive.' Careful records of individual babies show that there is often little or no *true* walking until a certain age and then within the course of a few days the child is running all about the house. When the walking pattern is finally integrated it is done swiftly, indicating that once the organism acquires the 'feel' of the act and has otherwise matured, the rest is a matter of smoothing off the rough spots in the performance. *This last apparently is the only real function that drill or practice in the narrow pedagogical sense actually has.* If one thinks of swimming as an act that is done 'perfectly' when a structure like a regular hexagon has been established, then the phases in the learning act may look like this:

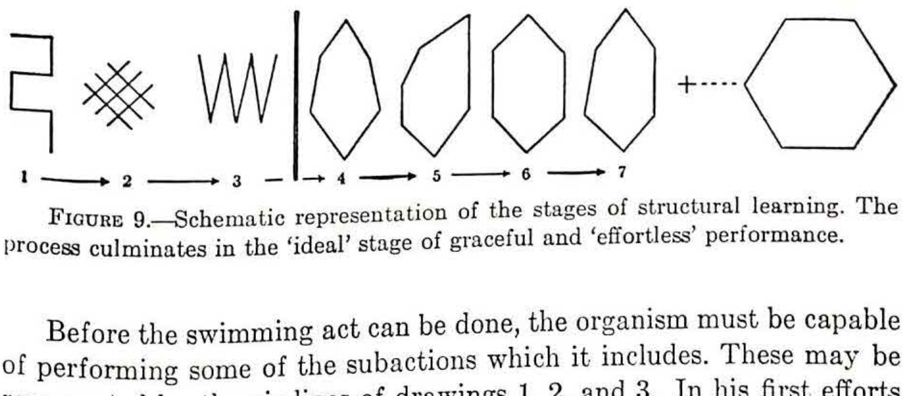


FIGURE 9.—Schematic representation of the stages of structural learning. The process culminates in the 'ideal' stage of graceful and 'effortless' performance.

Before the swimming act can be done, the organism must be capable of performing some of the subactions which it includes. These may be represented by the *six* lines of drawings 1, 2, and 3. In his first efforts to swim, the learner creates certain 'wholes' in which the six components of the mature act may appear. Actually the approximation to the final figure is greater than these first three sketches would suggest—they are to some extent a caricature of what he really does when he splashes about in a frightened and *ineffectively organized* way, which, to the observer, may appear as complete *disorganization*. The critical point is represented by the heavy black bar, for as soon as the learner has synthesized some kind of a hexagon, no matter how poor and irregular it may be, he is on the road to success in this skill. Concretely, this

means he can swim a few yards even if this is done clumsily and with intense exertion. The irregular hexagons of stages 5 and 6 symbolize the continuation of the 'amateur' status and its gradual assumption of more stable outlines at point 7 and beyond as 'perfection' is approached. The fact that subliminal percepts are generally dominant in both crudely diffused and finely focussed motor control does not change the general picture.

This account of the acquisition of any motor skill is highly unorthodox, but the writer's exposition of this before experienced teachers of many skill subjects shows it is pedagogically acceptable as a straightforward description of what happens and that at no point does it do violence to any known facts. This interpretation assumes that every distinctive motor skill—dancing, pole-vaulting, manuscript writing, etc.—has a characteristic structure and that the heart of such learning lies in the vivid sensory perception of this structure and its essential reproduction in the pattern of movement of the body of the learner. The fact that these structures are not exactly alike creates the difference known as 'style'; the fact that they are sufficiently alike to be given the same name (as when we say, "Mary and John are swimming in the pool") indicates that a recognizably common reaction-pattern has been established.

VI. Rote and Logical Memory Compared: The Issue of 'Meaning'

It is also helpful in building up a background of ideas about the learning process to administer the following four lists to one or more

List A	*List B*	*List C*	*List D*
zeb	sky	book	Jefferson
mij	pen	cover	early
kaf	girl	chapter	opposed
tig	was	page	every
lev	key	title	form
dup	far	author	of
han	may	publisher	tyranny
jex	who	preface	over
nol	knee	reference	man's
wuk	spin	heading	mind
gis	roll	footnote	and
yod	stay	index	body

subjects, or better, to serve as an experimental subject oneself. A comparison of one's behavior in acquiring and retaining these different series of twelve 'pieces' should prove enlightening concerning the value of unitary apprehension as a means of facilitating superior performance.

There are some likenesses and some differences in these four lists which are worth examining. There are twelve items in each and their arrangement is such that they have almost certainly never been seen in exactly this order by anyone before this moment. Analysis of what happens within the learner as he seeks to master these different configurations shows that he has most difficulty and least pleasure with A and the least trouble and the most satisfaction with D; B and C occupy an intermediate position. In A there is not only *more* to be learned against resistance, but to most persons there is much *less* to show for it after one has learned it; in D, on the contrary, the transitions from one component to the next are made gracefully so that one is not only carried onward but also upward. In A, the spatial relationships of sequence—in which the beginning and end are most sharply marked—are about all that this or any other list of nonsense syllables contain; other mental 'stuff,' apart from fugitive and bizarre associations is usually barren and limited in the extreme. In B, the separate words are readily perceived without any jar or irritation, but as disconnected words they are made to hang together by such artificial integrating devices as an image of a *girl* with a prominent *pen* in her hand seen against a vivid *sky*, etc. In C, the pieces snap together quickly because a single reading suffices to show that they are all characteristics of a printed volume, which provides a concrete and natural unity that is missing in B. In D, of course, one is dealing with an intelligible 'sentence' arrayed vertically; here the unity of what is learned is more than that of an 'image' and approaches that of an 'idea.' The learner usually experiences a sense of reward in having learned 'something' which is missing in the other three series. This feeling of having 'advanced' in some respect following a learning effort is of paramount importance, for if the subject believes he is 'not getting anywhere' his performance is all but certain to be unfavorably affected.

Because of the great educational importance rightly attached to the paired factors of 'meaning' and 'value' in all learning, it should be stressed that no experience or stimulus is ever meaningless or valueless

in a strict sense. It may have little meaning, a distorted meaning, or an ugly meaning; but anything that affects a person and provokes a reaction from him cannot be strictly devoid of meaning. The fact that he notices it and does something, however little, about it is behavioristic evidence that he finds *some* meaning therein. A page of shorthand to one unfamiliar with stenography is low in meaning, but to recognize it as shorthand, if that is all that can be done, is nonetheless a *significant* reaction. Even a nonsense syllable has some meaning to the learner—to identify it correctly as a nonsense syllable is a prerequisite to certain appropriate conduct in connection with it. An experience with zero meaning is psychologically nonexistent. Rote learning, the curse of all inadequate instruction, defines one end of the meaning continuum and logical or 'systematic' learning the other; but absolutely it is present all along the line.

Meaning itself is a field property of any experience to which the organism responds. Failure to respond in some form, no matter how maladaptive the reaction, is the only test of a truly meaningless situation. Change of meaning corresponds to an alteration in the membership-character of an object or event, i. e., the meaning shifts when the 'item' is perceived now in one field and now in another. A pun illustrates this plainly, as do punctuation and intonation, the organizing factors in written and oral speech, respectively. Meaning is primarily the creature of system and *order*. The learning superiority of list D to list B is to be ascribed to this attribute and to none other.

VII. Problem-Solving Behavior

All learning—to generalize on the basis of the admittedly limited material so far presented—is a redistribution of energy in different patterns than those which existed before an identifiable process of modifiability occurred. The significant learning that any of us do is largely centered about the solution of 'problems,' i. e., challenges to our adaptive powers. Subjectively, a problem may be solved (1) when an organism is emotionally *satisfied* with the results of its efforts to adjust; (2) when some observer with perhaps higher *standards of solution* considers it done; and (3) when the apparent *objective necessities or requirements* of the situation are genuinely met. These three criteria are probably all present in obvious or simple situations, but in many of the more elaborate animal experiments the joke was on the experimenter because the problem he thought he was setting for the

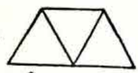
learner was not the one actually accepted by the animal as a result of his confrontation with the task-complex; small wonder that many animals have seemed frightfully dull in the laboratory when they insisted upon solving Problem A as the pressing issue they perceived in the set-up while the experimenter was annoyed because they did not show sufficient sensitivity to Problem B which his human constitution and interests led him to esteem more pressing! Similarly what the child sees as its most immediate problem may not be that upon which the teacher is insisting. These cases indicate that the *fields* of the learner and of the external observer, while usually overlapping, are far from identical—a methodological point of some importance in the identification of problems and in the appraisal of their solutions.

The configurationist holds that fundamentally all problems are solved as soon as the learner has achieved insight into their essential relationships. The use of the word 'insight' as an explanatory concept is decried by some as pure 'mysticism,' a charge that overlooks the fact that field psychologists are as 'hard-boiled' as any naturalists operating in this area of science, although behaviorism is popularly thought to be more tough-minded. Those who lack insight into the nature of insight apparently do so because they find the notion a bit vague and repugnant. Here we are up against the requirement that a tenable system of psychology must, among other things, explain the behavior of psychologists themselves as they accept or reject a given outlook.

Insight is a word derived from common speech and modified slightly in meaning to fit the needs of technical psychological discourse. In its simplest form it connotes *appropriate* behavior in the presence of any life-situation; e. g., the baby who uses a spoon to bring food to its mouth for the first time has a *fitting* conception about the relation of certain tools, distances, and objects to parts of his own body as his adaptive behavior plainly indicates. Insight thus does not refer exclusively to high-level and intricate conduct: When we assert that the book is on top of the table or that the pen is to the right of the pencil, we are properly reporting reality and give evidence of our understanding of spatial forces by the way we perceive such simple juxtapositions; similarly, the child who lifts his legs to mount a stairway shows that he appreciates what the demands of the objective situation are with respect to his bodily frame. Insight is really a kind of sight, i. e., a mode of perception. It is, like all psychological processes, a special kind of neural or cortical organization that is estab-

lished as soon as the organism achieves its purposes, i. e., it is the internally apprehended correlate of the 'closing' of an incomplete configuration whose very incompleteness has produced the 'problem' initially by keeping the learner in a state of tension.

To convince himself of the reality of the insight phenomenon, (although it would be a queer adult who had not had thousands of insights since he was born!) the reader should accept this assignment: Take six matches (or equivalents) and construct four equilateral triangles from them without breaking any of the matches. Stop your perusal of the text and work on this task until you succeed or are 'stumped.' * * * * * * Almost everyone places the sticks on a table top or some similar flat surface and attempts to produce the desired result by a variety of arrangements of the matchsticks. He is, of course, unsuccessful in his efforts since the problem cannot be solved on a two-dimensional basis. The only way to meet the conditions of the problem is to build a tetrahedron, a solid figure. Although the experimenter has not said so, the subject has spontaneously limited his chances of getting a solution by making the needless assumption that the triangles must all be in the same plane. Such an assumption, of course, restricts the subject's attempts at a solution within a fairly narrow frame. Greater elasticity of tacit assumptions together with a more definite picture of the exact assumptions that must be made constitute an important methodological device for increasing one's capacity to handle novel situations.

If one thinks of 'four triangles' as , it is clear at the very start that one cannot stretch six matches to make 12 sides; consequently, the need to save parts by having one match serve in overlapping fashion as the common side of two different triangles is indicated and one tends to visualize the final solution as taking this approximate form.  While one undoubtedly saves matches this way and is therefore encouraged to feel that he is on the road to a solution, the precise requirements of the task are obviously not satisfied. Nor can they be until one's imagination is liberated by the suggestion that the triangles do not need to lie in the same plane; then it becomes possible to make the further saving in sticks by increasing the number of common sides. This is the requisite insight, i. e., the organizing factor, that is delayed until inner matura-

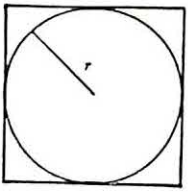
tion and outer 'experimentation' combine to yield the clue that disposes of this limited problem.

Of course, there have been 'trials' during the process; and obviously there have been 'errors.' But do these customary *accompaniments* of learning explain the heart of the learning itself? Probably no more than bank checks and copper pennies describe the essentials of a nation's economic life—a check-and-penny interpretation of economics certainly seems superficial, although no one denies the existence of these media of exchange. One could 'try and err' until doomsday, but if the necessary insight into a situation is not forthcoming, the problem remains unsolved. Insight and understanding are fundamental—the trial-and-error aspect is merely the outer shell referring to the tentative movements or preliminary attempts at organization. These initial efforts are not 'blind'; they always involve some loosely formed 'hypothesis' (go back to the matchsticks for evidence); the learner never goes randomly through his entire repertoire of behavior like a man testing a large bundle of keys on a lock in the dark but always limits his early endeavors in the light of restricted and not unreasonable probabilities. A man confined in a puzzle-box does not expect the recitation of *Hiawatha* or drawing a face in the sawdust to release him (unless his 'jailer' has arbitrarily imposed this condition); he rightly limits his exploratory activity to searching for 'mechanical' interdependencies which his *initial* (but not *final*) insight indicates as the most parsimonious use of energy. Within the limits of their comprehension and bodily machinery, all other animals react in much the same fashion.

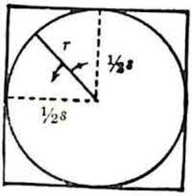
Insight may appear with different degrees of completeness. At its highest level it seems to take the form of 'foresight'; more commonly it emerges as the 'hindsight' following a more or less extended period of manual or mental exploration. It may be well to note, too, that there is *some* organization even on the pre-insight level. An analysis of a simple original occasionally given in high-school geometry should help clarify this central notion in Gestalt psychology and add a little more convincing evidence of its educational usefulness. The problem is "Find (or state) the area of the circumscribed square when only the radius of the inscribed circle is known."

Most persons (including even those of considerable educational attainments) are blocked in their efforts to find the solution largely because they have not established the 'habit' of literally seeing things

in a variety of ways. It is often necessary to 're-structure' a given pattern like the following drawing before an answer is possible. As long as the reader actually sees the radius as a radius and as nothing else, he is debarred from finding the solution by the inelasticity of his per-



ceptual responses. But as soon as he is able to react dynamically rather than statically to the first drawing, various possibilities begin to present themselves. As soon as the radius is no longer seen as a *radius* alone but also as *one-half of the side of the circumscribed square,* the problem is solved for the essential insight has emerged. In other words, effective thinking rests upon a perceptual reconstruction of this sort:



The power to visualize or to imagine the hitherto stable radius moved into either a horizontal or vertical position is the crux of the successful thought process in this case. All the required relations then 'snap together' into the awareness that the area of the circumscribed square is simply twice r multiplied by itself; or in symbols, $A = (2r)^2$. Keeping the initial situation as it was, blocked the solution, but *changing* it slightly and appropriately led to the correct answer. Such behavior is usually a favorable condition for furthering the appearance of the required insight.

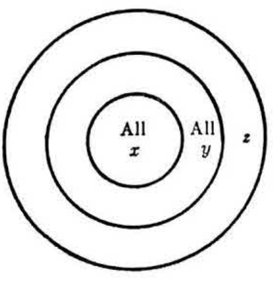
From the foregoing it should be easy to conclude that field theory leads to a closer amalgamation of the categories of learning and thinking than occurs in other systems of psychology. This is indeed the case; in fact, the thought processes, with their larger dosage of creativity and originality, receive preferred emphasis as being more characteristic

of human modifiability and problem-solving capacity than is true of 'learning' of the casual or memoriter sort which other schools of psychology have considered typical of our adjustments. The crucial role of insight in the 'higher' mental processes and the imperative need of schoolmen of some 'helps' or 'learning aids' for ensuring its presence where generalizations and abstractions are involved are readily discerned in what follows.

A useful, concrete method of promoting the ability to make valid inferences of a logical type was proposed about the middle of the eighteenth century by the eminent Swiss mathematician, Euler. It seems that he had a Russian princess as pupil who was not a ready learner and her tutor was driven to invent a number of pedagogical devices to simplify his instruction. The famous "Eulerian circles" of formal logic are a means of developing the power of inference on the abstract and general level by giving the problem in which they appear a direct perceptual character. The simplest illustration of this technique is found in the map-like representation of this standard syllogistic form:

$$\begin{array}{c} \text{All } x \text{ is } y; \\ \text{All } y \text{ is } z; \\ \hline \therefore \text{ All } x \text{ is } z. \end{array}$$

The truth or falsity or indeterminate character of the conclusion often fails to be discerned by those who have not developed facility in seeing whole-part relations. Consequently, if one makes a model or draws a picture which preserves the essential 'structure' of the three propositions, it should be possible to test the correctness of the conclusion.



Language obviously has a structural quality or internal design which permits one to convert the simple declarative statement "All

x is y" into a geometrical or topological equivalent, represented by the smaller circle x within the larger one, y. The fact that all x is y notoriously does not mean that all y is z; for this reason, the 'domain' of y is drawn somewhat larger than x since we know that it is at least as 'big' or inclusive. Yet all that may properly be inferred from the first proposition alone is that *some* y's are x's. The second statement (all y is z) is simply a continuation or expansion of the pattern of the first; hence another circle drawn round the region of y portrays the situation as given. Having done this, all one needs to do to check the conclusion that "all x is z" is to observe from the diagram that the field of x lies totally within the field of z; the proposition is then 'proved' or *seen* to be formally correct. Further one need not—indeed cannot—go, for human thought cannot be made more exact or precise than this. This is the limit of *clear* insight—it is practically the same as direct vision.

The laws of perception and the laws of thinking appear to have a common basis in the way in which they reflect external reality. Thinking seems to be, and probably is, a step further removed from the physical world than 'immediate' sensory perception; but as a mental process it is nonetheless like perceiving in the organization of forces. The fact that in critical instances, thought can be 'reduced' to perception suggests that this structural kinship exists even with the most abstruse thoughts. For example, the syllogism above, which is a bit obscure to many good minds in its verbal x-y-z form is clear enough when the relevant Eulerian circles are drawn as implied in the 'directions' expressed by the propositions; and there is no intellectual difficulty usually in following the form when it is clothed in this garb:

All Polynesians are human;
All human beings are mammals;

∴ All Polynesians are mammals.

There is little warrant for multiplying the illustrations further in this brief survey. Suffice it to say that insightful behavior is behavior that has seen the 'point' of the situation in which it occurs, that it is constantly and crucially aware of the dependence of suitable adaptations upon the accurate perception of interdependent field forces, that it occurs when (or after) an organized pattern has been constructed by

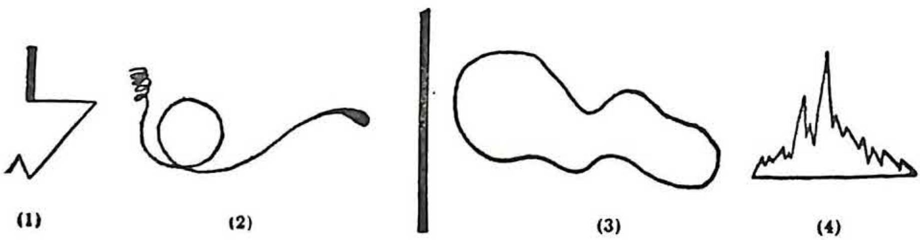
the learner, and that it involves response to, and mastery of, the broader principle manifested in a specific concrete problem. Both abstraction and generalization are transposable insights (as most insights are), and concepts could not be formed except on the basis of structural similarities (= insights into common features) among various experiences.

An insightful experience normally carries with it a convincing sense of the correctness of the apprehension, although unfortunately this may prove to be quite deceptive. In other words, *false* insights must be expected to occur as one class of variations within the wide world of individual and particular organizations; they are plausible mental organizations that seem to fit the situation but actually fail to do so, even though they may approximate the true solution. Presumably they arise as a result of the action of 'hidden' field forces which produce an illusory or delusive effect in thinking akin to that which evokes perceptual illusions of the sort shown in the Sander parallelogram (Fig. 5 above). The 'atmosphere effect' in formal propositions discovered by Sells and Woodworth is a case in point. The necessity for testing every persuasive intellectual construction with the deliverances of overt or active behavior is not eliminated by any field principle—indeed, theory and practice, thought and action, are not two different worlds, but as necessary to the attainment of adequate understanding as the *two* successive light exposures are to the creation of the phenomenon of apparent movement.

Similarity itself as a natural phenomenon is closely related to 'insight' and remains unintelligible in all systems save field psychology. Aristotle casually admitted it as one of the factors accounting for the "succession of ideas," and thus the Achilles' heel of associationism was established at its very birth. The British empiricists of the eighteenth century understandably found it hard to assimilate the similarity factor and tried, with doubtful success, to reduce it to contiguity in space or time, of which it was considered a special case. James Mill, however, was right—as a consistent associationist, he threw it out entirely, for it had no place in his tight little schema. But if similarity is nonetheless a perceptible quality in the real world, a system that excludes it must to that degree be 'unreal.' His son, John Stuart Mill, abler than the father, saw this point, and like the honest thinker he was, reintroduced "association by similarity," but was made uncomfortable because he had no satisfactory theoretical framework in which

to put it.[1] Today, in the hands of the field psychologists, "the stone that the builders rejected has been made the head of the corner." *Similarity is similarity of the total pattern and need have nothing to do with any of the parts.* A dish of cooked cauliflower reminds a small boy of cats' and dogs' feet—to what can this be attributed save to the structural design which, because it is common to both percepts, is the dominant impression? Similarity, like insight, cannot be understood apart from organized wholes.

A simple but slightly bewildering demonstration of the complete impossibility of explaining the common phenomena of 'similarity'—without which poetry and the other arts, and most forms of creativity and originality either could not occur or would be quite different from what they seem to be at present—can be made by the use of the odd figures below:



These are all 'nonsense' figures, i. e., drawings that have no definite conventional meaning and to which no learned response already exists. Ask yourself which nonsense name is more suitable to the respective members of the 1-2 pair above—"rulam" or "kadek." This seems like a ridiculous problem to present to any sane person for solution. Yet most persons (a statement easily verified by checking with a large

[1] In this respect, the situation resembles somewhat Thorndike's struggles to find room for such apparently necessary concepts as "belongingness" and "identifiability" (both good Gestalt notions) in his connectionist system. This represents one of his few lapses into eclecticism, i. e., theoretical inconsistency. Belongingness simply does not belong in an elementaristic psychology! Thorndike's utter honesty as an experimenter forced him to recognize the existence of forces which could be included in his frame of reference only by severely bending it. Friend, foe, and critic of Thorndikianism will do well to remember that there is a substantial difference between his *Educational Psychology* of 1913 and his profounder *Fundamentals of Learning* in 1932. The latter does incorporate some field notions, probably in an effort to meet the newer Gestalt critique of his animal researches, although the earlier orientation is still dominant in most interpretations.

group of subjects) assign *kadek* to (1) and *rulam* to (2), and feel strongly that such matching is genuinely appropriate even though their reasons for this choice may be vague. If chance dictated the selection, a 50-50 distribution should occur; actually a group agreement of less than 80% is unusual. Verify this puzzling relation with sketches (3) and (4). To which figure do "peeweetee" and "mahloona" belong? The overwhelming judgment of 'novices' (i. e., natural observers unprejudiced by rival theories!) is that *mahloona* is the better label for (3) and *peeweetee* for (4).

Apparently the organism senses directly the fact that although one stimulus pattern is primarily auditory and the other mainly visual, they are alike in their structural properties; the suprasensory 'formal' design discernible in both is the same. *Kadek* can be 'translated' by the sharp 'stops' and angularity of the accompanying drawing; *rulam*, on the contrary, has a soft flowing quality. *Peeweetee* when spoken gives a constricted pointed effect, presumably as a result of the high pitch of the component vowel sounds; *mahloona*, by contrast, has the low, spreading, voluminous quality given by deeper pitches. The 'symbolism' consequently feels right to one who lets these stimuli act upon him. To the objection that this is mere poetry, metaphor, and 'wild' analogy and not hard-headed science, field thinkers retort that the perception of similarity between apparently discrete entities is precisely what gives to the human creations their charm and their deeper significance, and that natural law itself as we formulate it rests upon such commonly overlooked similarities in experience. Anyone who reflects upon the spontaneous and universal naming of the curious limestone cavern formations when seen in dim artificial light must recognize the normal and logical character of this experience. Were teachers and pupils to appreciate this point it would accomplish an educational revolution of the first magnitude.

VIII. Learning as Differentiation: Mental Development a Process of Moving from the Vague to the Particular

Hitherto we have treated learning principally in its synthetic aspects with 'integration and reorganization' as the leading features. These terms describe the core of the field-theoretical approach to modifiability, but they are far from exhausting it. Apparently learn-

ing is not just a matter of construction or 'building-up'—it also involves stages where something like 'tearing-down' occurs. These processes are not to be construed as literally opposed to each other or as representing wholly distinct mental activities; they occur more or less simultaneously in the same concrete situation and should be viewed as complementary phases of the more fundamental processes of growth and maturation.

The controlling monistic attitude of organismic psychology impels it to model its psychological interpretations after the clues provided by the anatomical and physiological features of the body. Learning after all is not a special 'spiritual' matter but as natural a process in the living system as breathing and digesting. Mental development notoriously parallels physical development, particularly in the first two decades, when the human is commonly under school influences. In the unborn child one sees certain 'rules' or bodily growth that, by the universal route of 'similarity,' provide the insight into the essentials of mental growth, which, according to the field postulate, must follow the *same* patterns. The fertilized egg has a minimum of structure, but by interaction with a nutrient environment, it becomes progressively more heterogeneous. It 'splits' repeatedly, produces members and extends them in fixed directions, and changes itself internally so that almost all resemblance to its microscopic origin is lost. The simplest way to schematize this complex succession of events is to portray the relationships as follows:

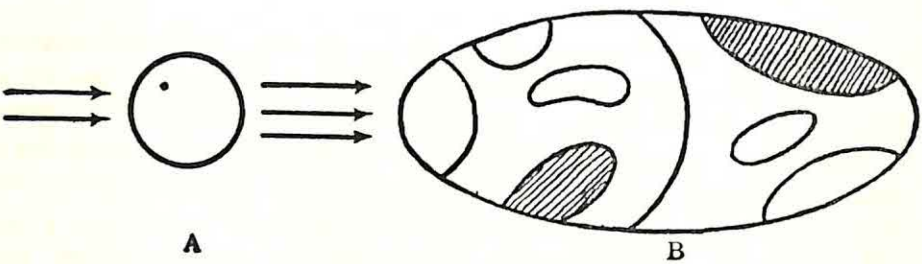


FIGURE 9.—One greatly over-simplified method of representing the development of the individual human organism. *A* is the original undifferentiated state of the fertilized egg; *B* is the same system in a more mature phase of differentiation: the arrows to the left of *A* may be thought of as standing for 'hereditary factors' and 'external conditions,' respectively; the arrows to the right of *A* may be construed as the three processes of 'cell-division,' 'differentiation,' and 'growth' in the narrow sense of additional bulk. Remember that this schema refers not only to 'biology'—it is also deemed to be literally representative of genetic psychology.

This picture of growth is important if for no other reason than its suggestive and analogical value for many problems in educational psychology. The way in which a child's organism is built up may well be the basic pattern or paradigm followed by all forms of later development which he exhibits. Mental (or neural) growth reveals many phenomena that strongly resemble in their design those encountered in tracing the successive phases by which a fertilized egg becomes an embryo, an embryo a foetus, a foetus an infant, and a child an adult. Perceptual growth, or the method by which one becomes intimately acquainted with the details of a visual object, reveals a parallel that is almost too perfect to be true. The reader may test this upon some friend by using the stimulus-pattern shown in Fig. 10 in the following way:

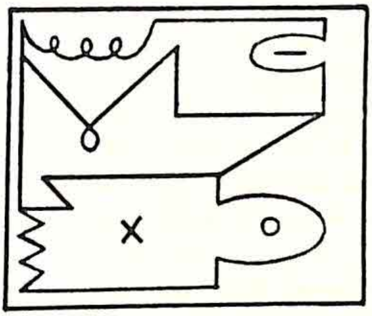


FIGURE 10.—A nonsense drawing which can be used to illustrate the growth of a percept from the undifferentiated to the differentiated stage.

Tell your acquaintance that he will be shown an unfamiliar figure for a very brief moment and that he should try to copy it exactly as seen upon a sheet of paper. He will probably need several exposures before he gets it essentially correct. Tell him to make each drawing upon a separate sheet and to number the pages consecutively. Each sketch must be made independently. The first reproduction will probably catch the *general outline* of Fig. 10 with amusing errors and omissions of details. Later drawings show that 'more' of the items correspond exactly to their place in the original. This progression from a vague, unclear, and unstable 'something' to a more sharply defined and accurately scaled percept is one form of cognitive growth. The fact that the term 'differentiation' fits this type of situation so well is probably not accidental, but a symptom of the underlying kinship between the process by which our organs emerged from an organ-less

entity and the manner in which we become oriented in the visual world. All behavior is full of examples of such correspondence.

Clearly then, the life cycle of all organisms, including man, reveals a progression from a relatively undifferentiated, homogeneous stage to a more elaborate and internally differentiated condition. *When this activity occurs with the perceptual controls of conduct we call it learning.* Consider our first impression of an individual's face. All we get initially is a comparatively undifferentiated picture in which general or Gestalt attributes are dominant, such as an awareness that this is a male rather than a female face, a young and not an old countenance, a handsome rather than a forbidding visage, a friendly glow instead of hostile features, etc. These are the 'vague' aspects to which we react originally. Suppose now we linger with this newcomer and continue to 'study' his looks. The face inevitably begins to 'break down' under inspection and the observer gathers more details—brown eyes, large straight nose, clear skin, thin hair, rounded chin, and the like. These parts 'pop out' of a mass of hitherto unseen relations, even though the total effect was well established at the start.

Compare this familiar and undramatic experience with the way in which the embryo is converted into a foetus and the foetus into a child. One month after fertilization the 6 mm. creature is not distinctively human—it is at best merely identified by the ordinary onlooker as the young of some animal. But by the end of the second month a miniature but recognizable human being has taken form. Why? Because differentiation has advanced in the direction characteristic of our species. Growth takes place from the larger centers outward: arm bones appear before hand bones, leg bones before foot bones, and the backbone before the attached ribs. Even 'closure' occurs, since the face grows together from both sides—hair-lipped persons represent cases where this embryonic closing has not been pursued to its normal conclusion.

Now shift your attention to the behavioral field. Is not our first acquaintance with any new stimulus or response (notably where these are complex) marked by this relative absence of differentiation? Ask many an adolescent what psychology is and he will reply, "Oh, it has something to do about the mind and brain." This crude picture is refined in one who has had an elementary course in this subject, and obviously it is highly differentiated (i. e., rich in parts) in the psychologist who is professionally concerned with it. What is technically called discrimination learning is this same type of reaction to dif-

ferences. The ability to distinguish between a king and a president was used by Binet as a measure of intellectual growth. A stranger to Manhattan first discovers that it is much longer than it is wide and that the street-pattern is that of a regular checkerboard save for some older downtown sections. But a native New Yorker has a far more differentiated picture of one-way streets and the direction of traffic permitted, the location of 'poor' and 'rich' districts, where the garment industry is concentrated, etc. The originally plain and uncomplicated contour has had many details 'etched' into it.

Plainly a large amount of learning, if not all, exhibits this swing from a crude massive whole with a minimum of internal organization to another whole that reveals a pronounced articulation among its many parts. The fact that wholes remain wholes indicates that integration is preserved while the differentiation process proceeds abreast; the total system does not normally fall apart merely because new pieces appear within it. Educationally, one task of teaching that assumes greater significance in the light of this discussion is the function of enabling pupils to see differences where formerly they saw only likeness or (reverting to the previous section) to perceive likenesses where others discern naught but differences.

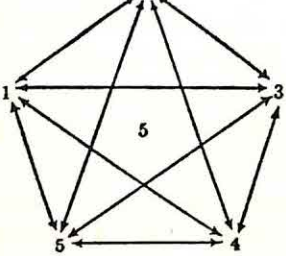
IX. Broader Pedagogical Implications of the Field System

Because the reference frame of the educator tends to be the world of the school and the classroom, he is easily led to forget that no single system of psychology was ever developed with the problems of the teacher and pupil as its primary source of inspiration, although it is quite true that exponents of some viewpoints have been more concerned about them than others. The application of configurationism to educational questions is one of the purest instances of an importation from outside the professional circle. The technical utilization of this approach is therefore a problem best solved by competent pioneers who have caught their directives from the most recent philosophy, physics, biology, and psychology, and who have sufficient mastery of human and social relations to guide the course of personal improvement in others by these imperatives. Transposability, of course, must occur before any valuable effects are achieved.

In so far as the field theory here outlined can be compressed into a single precept it could be phrased in the form of the following guide

to wise teaching and learning, viz.: *Always consider the whole situation before responding.* Specifically, this means such things as (1) not teaching anything about Afghanistan without simultaneously clarifying Afghanistan's position with respect to its Asiatic neighbors; (2) stressing the essentials of an act and not its 'trimmings'; and (3) placing every experience, old or new, into its larger setting. The number of precise illustrations and recommendations is all but endless; loss of temper, e. g., is to be interpreted as a reaction to an overenergized part of a situation in which balance is literally restored by a more even response to the whole field.

These few hints, however, are helpful only to one who appreciates the larger context from which they are derived. Perhaps the key conception is best conveyed by this vein of thought: Suppose one were asked to state who knew more about a certain field of study—the person who was familiar with five facts or the one who knew twenty. We may assume the facts themselves to be of equal importance. Without much reflection, most persons are disposed to say that of course it is more desirable to be acquainted with twenty facts about a given issue than with five—indeed, it is four times as good! However, suppose one student knew these five facts in all their permutations and combinations with each other, and another knew his twenty facts merely as discrete experiences. Symbolically, the situation might look like this:



versus

20
. . . .

Obviously, *more* (both of experience and of meaning) *may* reside in the organized pentagon than in the purely linear dot series. Whether it actually does, of course, depends upon some empirical check. The present discussion follows Koffka in the not unreasonable assumption that this will prove to be the case.

An old Latin proverb declares, *Non multa sed multum* (Not many, but much). The distinction between sheer frequency or amount of in-

formation about a problem and the focal grouping of such knowledge is the difference between ineffective and effective organization of material. One's contacts with the raw materials of educational psychology —or any other 'segregated' subject matter—should not be such that one cannot see the forest on account of the trees. Perspective comes as a result of sensitivity to interrelations. *No two items, no matter how far apart they may seem to be, should be learned without asking what is the nature of the relation between them.* To be sure, not all relations are fruitful any more than the fundaments between which the relations obtain are inherently of great value. But the only way to mount to higher and higher syntheses is to adopt and maintain a 'systematic' attitude of seeing events and properties in their togetherness rather than as isolated happenings in a 'rag-bag' universe.

Sometimes a very simple but vivid illustration will do more to convey an idea of the possible ramifications of a theoretical position than dozens of supporting experiments. At least this was the case with the writer in the family incident now to be reported. When the oldest child was about 2½ years of age she happened to hear some adults use the word "thigh." At the supper table she asked, "Daddy, what is a thigh?" Her father answered by pointing to his own thigh and saying, "This is my thigh; now find yours." This she did immediately and correctly. She was then directed to "go touch Billy's thigh" (a playmate seated next to her). This was also done promptly and properly; incidentally, although she and her father had tapped the *right* thigh, in the case of the neighbor's boy the *left* thigh was touched, indicating that the learning had been swiftly generalized and not kept specific. A thigh has meaning only as part of the bodily structure; it is an extended muscular region that lies between the knee and the hip; it is meaningless unless referred to the whole of which it is a part. Here, too, is a case of elemental insight when *one* occurrence seemed to ensure permanent mastery. There is nothing novel about this incident; it serves merely as a convenient illustration of the way in which all children acquire words and their corresponding concepts when they are presented in the field to which they inherently belong.

Ideally, field theory when applied to education or any other of the 'practical' institutional concerns of mankind is itself just another of the many cases of transposability to which it attaches no more than routine significance. Actually, the variety, intricacy, and subtlety of classroom situations make it impossible to erect an adequate tech-

nology for the schoolman by just supplying him with a 'world view,' a collection of evidence to support it, and a group of aphorisms and exhortations by which to implement it. But it is equally impossible or impracticable to deal with every imaginable type of concrete situation and to prescribe the wisest course of action in detailed empirical style. The educational psychologist is compelled, therefore, to use a blend of what may be called systematic or 'rational construction' and case-analyses in training teachers for the better and more economical development of those traits of personality which our culture values. If he is self-critical (as every intelligent person presumably should be and not just educators and psychologists!), he will recognize that many systems, including the one he favors sometimes for no better reason than that it is congenial to his temperament, represent different *weightings* and emphases in a common body of specialized knowledge. Why these weightings should differ as they do is a significant genetic problem whose solution must be deferred until the arrival of a mature psychology of the psychologist. Even the boldest field theorist—and boldness is a conspicuous attribute of this form of speculative activity—appreciates the vast empty stretches which his system leaves untouched; it is as though the full circle of 360° were forcibly suggested but not realized by an arc of but 80°.

None of these qualifying remarks implies that advocates of a field theory of learning are ordinarily unsure or hesitant about their recommendations. The behavioral deductions from certain grand principles are usually too clear to permit such diffidence. On the following points, a conviction approaching certainty exists:

1. That learning is best motivated by goals established or accepted by the learner as a result of his needs;

2. That impression, correlation, and expression are all required before a complete learning act occurs;

3. That project learning and systematic course learning are not irreconcilable antinomies but appropriate to different levels of maturity in the content involved;

4. That motivation follows the principle of functional autonomy, i. e., any act, once begun, is carried forward by its own incompleteness and future reference to other emerging goals without constant reliance upon the original impulse;

5. That interest depends upon some congruency between the activity or stimulus and the existing personality organization of the

learner, and that without this condition, instruction should not be attempted if it seeks to be efficient;

6. That the process of *gradual* organization, the slow transition from a worse to a better state of affairs, from a bad to a good gestalt, is just as important for the psychology of meaningful learning as is the 'sudden' flash of insight;

7. That the conditions of learning should provide opportunity for the continuous modification and change of the pattern of response;

8. That parts and wholes are never absolutes, for every whole is a part to some larger whole and every part is a whole to some smaller part;

9. That present learning is *less* dependent upon previous experience and the adequacy of earlier skills and information than upon the clarity, field properties, and excellence of organization of the learning material itself;

10. That the organism's purposes decide for it when it shall consider anything as learned;

11. That errors are usually testimony that the task is too severe for the learner's level of maturation and that material should be so graded or paced that a minimum of mistakes occur;

12. That creativity and originality are commoner among children and all persons than educators usually believe, and that a field viewpoint toward spontaneous behavior and productivity can heighten the plane of performance in these areas;

13. That orientation, general education, and survey courses harmonize best with the nature of early mental development, but that specialized courses are justified when growth has proceeded sufficiently *via* differentiation;

14. That forgetting is an *active* process, probably involving the loss of an item's place in some memory framework;

15. That the more systematized our experiences are, the less likely we are to forget any of them;

16. That transfer is real and positive and has no limits save those imposed by the nature of the world in which the pertinent configurations are found, i. e., some patterns occur frequently and others rarely;

17. That *much* rather than *many* should be the pedagogue's curricular watchword;

18. That pupil choice rests upon the fact that each human body is an independent energy system with its own special requirements and that such preference should dictate educational policy save where the organism itself or other organisms would clearly be damaged thereby;

19. That values and facts are both realities in human experience and intertwine in every situation we face;

20. That Matthew Arnold's eulogy of Sophocles as one who "saw life steadily and saw it whole" remains a valid picture of the end toward which personality growth should constantly be directed.

There are many other 'maxims' that might be added. But perhaps the reader is now in an organic state that will permit his extension of this list to a full hundred!

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CHAPTER VI

FIELD THEORY AND LEARNING

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I. Field Theory

I have been asked to begin this short discussion of a field-theoretical approach to the various problems of learning with a general statement about field theory and psychology. The following characteristics of this theory seem to me particularly important: the use of a constructive rather than a classificatory method; an interest in the dynamic aspects of events; a psychological rather than a physical approach; an analysis which starts with the situation as a whole; a distinction between systematic and historical problems; a mathematical representation of the field. To each of these points, I should like to make a few more or less apodictic remarks, referring the readers to more detailed discussion elsewhere.

1. Constructive Method

As any science, psychology is in a dilemma when it tries to develop 'general' concepts and laws. If one 'abstracts from individual differences,' there is no logical way back from these generalities to the individual case. Such a generalization leads from individual children to children of a certain age or certain economic level and from there to children of all ages and all economic levels; it leads from a psychopathic individual to similar pathological types and from there to the general category 'abnormal person.' However, there is no logical way back from the concept 'child' or 'abnormal person' to the individual case (38). What is the value of general concepts if they do not permit predictions for the individual case? Certainly, such a procedure is of little avail for the teacher or the psychotherapist.

This problem has been acute in other sciences. In the time of the Greeks, geometry shifted from a 'classificatory' method (which groups

geometric figures according to 'similarities') to a 'constructive' or 'genetic' method (which groups figures according to the way they can be produced or derived from each other). Ever since, the 'genetic definition' has dominated mathematics. In physics, a similar development occurred at the time of Galileo (48). Biology tried to take a major step in this direction when the system of Linnee was superseded by that of Darwin.

The essence of the constructive method is the representation of an individual case with the help of a few 'elements' of construction. In psychology, one can use psychological 'position,' psychological 'forces,' and similar concepts as elements. The general laws of psychology are statements of the empirical relations between these constructive elements or certain properties of them. It is possible to construct an infinite number of constellations in line with those laws; each of those constellations corresponds to an individual case at a given time. In this way, the gap between generalities and specificities, between laws and individual differences, can be bridged.

2. Dynamic Approach

Psychoanalysis has probably been the outstanding example of a psychological approach which attempts to reach the depths rather than the superficial layers of behavior. In this respect, it has followed the novelists of all periods. Psychoanalysis has not always kept in line with the requirements of scientific method when making its interpretations of behavior. What is needed are scientific constructs and methods which deal with the underlying forces of behavior but do so in a methodologically sound manner. (The term 'dynamic' here refers to the concept 'dynamis' = force, to an interpretation of changes as the result of psychological forces.)

The points mentioned under the above headings are at least to some degree recognized by other theories. The next two points, however, are more specific to field theory.

3. Psychological Approach

Field theory, as any scientific approach to psychology, is 'behavioristic,' if this means the tendency to provide 'operational definitions' (testable symptoms) for the concepts used (52). Many psychologists, particularly those who followed the theory of conditioned reflex, have confused this requirement for operational definitions with a demand

for eliminating psychological descriptions. They insisted on defining 'stimuli' superficially in terms of physics. One of the basic characteristics of field theory in psychology, as I see it, is the demand that the field which influences an individual should be described not in 'objective physicalistic' terms, but in the way in which it exists for that person at that time (cf. the concept "behavioural environment" of Koffka, 32). A teacher will never succeed in giving proper guidance to a child if he doesn't learn to understand the psychological world in which that individual child lives. To describe a situation 'objectively' in psychology actually means to describe the situation as a totality of those facts and of only those facts which make up the field of that individual. To substitute for that world of the individual the world of the teacher, of the physicist, or of anybody else is to be, not objective, but wrong.

One of the basic tasks of psychology is to find scientific constructs which permit adequate representation of psychological constellations in such a way that the behavior of the individual can be derived. This does not weaken the demand for operational definitions of the terms used in psychology, but it emphasizes the right and necessity of using psychological concepts in psychology.

The properties of the 'life space' of the individual depend partly upon the state of that individual as a product of his history, partly upon the nonpsychologic—physical and social—surroundings. The latter have a relation to the life space similar to that which 'boundary conditions' have to a dynamic system. Gestalt theory has much emphasized (perhaps overemphasized in the beginning) certain similarities between the perceived structure and the objective structure of the stimuli. This does not mean, however, that it is permissible to treat stimuli as if they were inner parts of the life space (rather than boundary conditions), a common mistake of physicalistic behaviorism.

4. Analysis Beginning with the Situation as a Whole

It has been said frequently that field theory and Gestalt theory are against analysis. Nothing could be more erroneous. In fact, field theory criticizes many physicalistic theories for their lack of a thorough psychological analysis (see example later); a great number of situations have been dealt with much more analytically by the field-theoretical approach than by any other approach. [A survey of the literature using topological concepts can be found in Lewin (42, pp. 9-42).]

What is important in field theory is the way the analysis proceeds.

Instead of picking out one or another isolated element within a situation, the importance of which cannot be judged without consideration of the situation as a whole, field theory finds it advantageous, as a rule, to start with a characterization of the situation as a whole. After this first approximation, the various aspects and parts of the situation undergo a more and more specific and detailed analysis. It is obvious that such a method is the best safeguard against being misled by one or another element of the situation.

Of course, such a method presupposes that there exists something like properties of the field as a whole (30), and that even macroscopic situations, covering hours or years, can be seen under certain circumstances as a unit (3). Some of these general properties—for instance, the amount of 'space of free movement' or the 'atmosphere of friendliness'—are characterized by terms which might sound very unscientific to the ear of a person accustomed to think in terms of physics. However, if that person will consider for a moment the fundamental importance which the field of gravity, the electrical field, or the amount of pressure has for physical events, he will find it less surprising to discover a similar importance in the problems of atmosphere in psychology. In fact, it is possible to determine and to measure psychological atmospheres quite accurately (43). Every child is sensitive, even to small changes in social atmosphere, e.g., in the degree of friendliness or security. The teacher knows that success in teaching French, or any subject, depends largely on the atmosphere he is able to create. That these problems have not been properly dealt with in psychology until now is due neither to their unimportance nor to any specific difficulty in the empirical determination of atmosphere, but mainly to certain philosophical prejudices in the direction of physicalistic behaviorism.

5. Behavior as a Function of the Field at the Time It Occurs

It has been accepted by most psychologists that the teleological derivation of behavior from the future is not permissible. Field theory insists that the derivation of behavior from the past is not less metaphysical, because past events do not exist now and therefore cannot have effect now. The effect of the past on behavior can be only an indirect one; the past psychological field is one of the 'origins' of the present field and this in turn affects behavior. To link behavior with a past field therefore presupposes that one knows sufficiently how the past event has changed the field at that time, and whether or not in the

meantime other events have modified the field again. Field theory is interested in historical or developmental problems, but it demands a much sharper analytical treatment of these problems than is customary, particularly in the theory of associationism (40, p. 165, footnote).

6. Mathematical Representations of Psychological Situations

To permit scientific derivations, psychology must use a language which is logically strict and at the same time in line with constructive methods. As late as 1900, much argument was going on as to whether the use of numbers should be permitted in such a 'qualitative' science as psychology. Many philosophers argued against such use on the grounds that numbers are characteristics of the physical sciences. Today, the use of numbers in psychological statistics is well accepted. However, there is some opposition to the use of geometry in representing psychological situations on the same ground. Actually, geometry is a branch of mathematics and as such is eligible as a tool in any science. Certain types of geometry, like topology, are most useful in representing the structure of psychological situations (39, 40). Topological and vectorial concepts combine power of analysis, conceptual precision, usefulness for derivation and fitness for the total range of psychological problems in a way which, in my opinion, makes them superior to any other known conceptual tool in psychology.

At the moment, field theory is accepted probably by only a minority of psychologists. However, there are increasing signs that practically all branches of psychology—such as perception psychology, psychology of motivation, social psychology, child psychology, animal psychology, and abnormal psychology—are moving in the direction of field theory much faster than one would have expected ten years ago.

II. Learning: A Term with Many Meanings and a Disturbing History

The term *learning* is a popular one which refers in a more or less vague way to some kind of betterment. Around 1910, students of psychology were taught to explain any change in behavior either by learning (which meant improvement in speed or quality), or by fatigue (which meant decrease in speed or quality), or by a combination of the two. Actually, the term *learning* refers to a multitude of different phenomena. The statement, "Democracy, one has to learn; autocracy is imposed upon the person," refers to one type of learning. If one says

that the "spastic child has to learn to relax," one is speaking of a different type of learning. Both types probably have very little to do with 'learning French vocabulary,' and this type again has little to do with 'learning to like spinach.'

Have we any right to classify the learning to high-jump, to get along without alcohol, and to be friendly with other people under the same term, and to expect identical laws to hold for any of these processes?

The theory of association and its successor, the conditioned reflex theory, speaks of association in regard to any type of psychological processes and assumes the laws of association independent of psychological content. This practice has strengthened the tendency toward a broad usage of the term learning. Some psychologists identify learning with any change (34). Sometime, we hope, psychological theory will be so advanced that, as in modern physics, a few very general formulae will permit the derivation of most psychological phenomena. However, a science cannot reach this state without first having developed more specific laws, each representing the nature of certain types of processes.

Today, attempting to find the laws of learning in that broad sense seems comparable to an attempt by the chemist to develop *one* chemical formula for all the material contained in a building instead of grouping these different materials according to their chemical nature and finding the properties for each type of material separately. Similarly, the term *learning*, in the broad sense of 'doing something better than before,' is a 'practical' term referring to a variety of processes which the psychologist will have to group and treat according to their psychological nature.

Within what is called learning, we have to distinguish at least the following types of changes: (1) learning as a change in cognitive structure (knowledge), (2) learning as a change in motivation (learning to like or to dislike), (3) learning as a change in group belongingness or ideology (this is an important aspect of growing into a culture), (4) learning in the meaning of voluntary control of the body musculature (this is one important aspect of acquiring skills, such as speech and self-control).

The history of psychology has done much to confuse rather than to clarify this situation. The classical theory of association, as stated by such an excellent experimentalist as G. E. Mueller (45), is based on the following theorem. If two experiences (or actions) *a* and *b* occur

frequently together or in direct contiguity, an association between them is established. This association is operationally defined as the probability of producing *b* if *a* occurs alone. The strength of this association is a function of the number of repetitions. Originally, associationism was concerned with the connection between 'ideas'; in other words, with knowledge or intellectual processes. However, associationism reached out farther and farther until it prided itself on explaining with one law not only the process of rote learning but any kind of intellectual process, behavior habits, values, and particularly directed actions. In other words, association was supposed to explain both motivation and cognition.

The explanation, following closely Darwinistic ideas of directed actions as the result of factors which do not contain the concept of directedness, was considered a particularly important achievement because at that time the controversy between the teleological and causal explanations of behavior was acute. The outstanding characteristic of a scientific causal explanation was incorrectly seen as requiring the avoidance of the concept of direction. This view was held in spite of the fact that one of the basic concepts in physics, the concept of physical force, refers to a directed entity (a vector, in terms of mathematics). The development of associationism can well be viewed as a struggle with this very problem. Ach's theory (1) of "determining tendency" (1910) and Thorndike's "law of effect" were attempts to recognize the particular role which goals, needs, or other 'directed' factors play in behavior without giving up the basic position of associationism. Both have singled out one special type of experience (reaching the goal, getting what is called a 'reward,' or setting up an intention) as particularly important for the formation of associations. Ever since, leading representatives of the theory of associationism and conditioned reflex have given goals an increasingly dominant role in their derivations.

It is probably fair to say today that, in regard to questions of motivation, the original position of associationism is all but abandoned. One is tempted to say that a theory of needs very similar to that accepted in field theory has been taken over, although a somewhat peculiar type of terminology makes this fact less apparent. Instead of speaking, for instance, of 'consumption,' conditioned reflex theory speaks of 'goal response.' This goal response is not defined, as one might expect, as any reaction to a goal stimulus; rather, the other way around, all behavior which reduces need tension, and only such be-

havior, is called goal response (8, p. 6). In two other respects also, a change in the direction toward field theory is apparent.

a) The theory of conditioned reflex had tried to be behavioristic in the sense of physicalism and had shied away from all psychological terms as being unscientific. After heated discussion, the concept 'goal' (53) was finally accepted in spite of its psychological character. Today, even terms like 'expectation' are admitted to the vocabulary of the conditioned-reflex psychologists (19, 23). In other words, a trend toward psychological concepts is visible, and it seems that classical physicalistic behavorism is slowly being reduced to an approach which demands the correct technical requirements of operational definition.

b) All approaches to psychology are apparently becoming more and more aware that the theory has to include the particular pattern of factors existing at a given time. Such a leading conditioned reflex theorist as Hull (22) recognizes this point. On the whole, however, this recognition has led toward a complication rather than a clarification of the theory of the conditioned reflex.

In general, one might say that the history of associationism and its attempt to cover all types of psychological processes by one law has been much influenced by philosophical considerations (any such attempt is necessarily metaphysical in character). It was a correct fight against the teleological attempt to derive present behavior from the *future*. The desire to replace such an explanation by causal explanations led to the tendency to derive behavior from the past. This emphasis on the *past* has contributed much to the overemphasis on the problem of learning. It has also made psychologists suspicious of all directed entities. The further development has clarified the difference between teleology and the use of directed factors. This has prepared the way for an understanding that causal explanations actually mean a derivation of behavior from the *present* field—a principle that is basic to field theory. It means, also, a more adequate understanding of the proper place of the problem of learning in psychology.

Looking back over the history of the experimental studies of the psychology of learning, the distinction of two main lines of development may help to clarify the still very unclear picture. One line deals with learning as related to motivation; the other, with learning as related to cognition.

a) The term *habit* can be used as a prototype of a concept in which the classical law of association is linked with action rather than

cognition and is interpreted as a psychological force of a character similar to motivational forces. In my view, the most sincere attempt to follow up the implications of this aspect of associationism has been made by Ach (1). He argued correctly that if repetition creates habits, it should be possible to measure the strength of the will by measuring the number of repetitions necessary to overthrow the effect of an intention to act in a different direction. His positive results have not been able, however, to stand up. It has been shown (36, 37, 49) that even an extreme number of repetitions does not form a measurable obstacle to carrying through a differently directed intention. To understand the various phenomena, it is necessary to distinguish 'executive habits,' which do not have the character of motivational forces, from 'need habits,' which imply the existence of a need (or quasi-need) or its fixation on certain valences. In other words, it is necessary to distinguish the motivational from the cognitive problems, and to study the laws of each of them in detail. Then the special role of each type of factor has to be determined for the different constellations.

Unfortunately, the fact that many learning experiments have been done with animals has made a clear separation of motivational and cognitive problems very difficult (2, 34, 53). Adams, Tolman, and others have stressed this point strongly. The work on latent learning (7, 53) has been one of the important results of this better conceptual analysis. However, even today, it is probably more difficult to distinguish these aspects properly in experiments with animals than in those with humans.

b) The second line of development deals with the specific laws which govern learning in the sense of change in cognitive structure. It becomes more and more apparent that even in this, its original realm, associationism is much too primitive a theory. The problems of insight, of acquiring knowledge, and of other kinds of change in cognitive structure, seem to be closely related to those laws which govern perception (27, 30, 32) and determine the structure of the perceived field. Doubtlessly, great progress has been made in the study of these problems. In view of Professor Hartmann's treatment of perception in this Yearbook, I shall not discuss the relation between perception and learning, which is one of the crucial problems of learning.

The lack of clarity in the discussions of learning in relation to motivation and cognition seems to be connected mainly with the term memory. It may mean the individual's views of his own past. The

problems of memory in this regard are part of the problems of time perspective. On the other hand, speaking about memory processes, one may refer to the structural similarities and differences between life spaces of an individual existing at different times. The problems of plasticity of the psychological field and of the forces which create changes are of prime importance for this question. The relation between memory and learning is highly complex. Following the experiences of the past is one way of learning from experience. However, frequently one has to learn *not* to follow the same procedure one used previously; one must learn to be guided instead by something like a theoretical analysis of the present situation. One of the reasons for slow progress in social life is that, in the field of politics, people are more apt to go by the way of tradition than to follow the second procedure.

Space does not permit here any attempt to survey systematically the facts of learning, much of which the reader will find in the textbooks. I shall merely try to point out the various types of problems by way of very simple examples, without attempting a mathematical treatment. I shall emphasize those factors which the teacher is less likely to think about in considering the problem of learning, but which nevertheless should be included in a field-theoretical approach.

III. Learning as Change in Knowledge (Cognitive Structure)

1. Differentiation of Unstructured Areas

An individual moves to a new town. Slowly he learns to find his way around geographically and socially. What are the psychological changes called *learning* in this case? The individual arrives at the depot as a stranger. He may have secured an apartment in advance. He knows his house number, but standing at the station and failing to have a map of the town, he does not know how to get there. The situation corresponds to Figure 1. There is an area corresponding to the station (ST) where the person (P) is located. There exists another area in his life space corresponding to the apartment (A). Between these two areas lies a region which has psychologically the character of being unstructured (U), that is, the stranger does not know how to go from the station to his apartment, how far it is, and how the area around his apartment looks.

This unclearness is of decisive importance for his behavior. He does

not know which streets around the station lead to, and which lead away from, the apartment. In other words, it is not defined what 'direction' from the station to the apartment means.

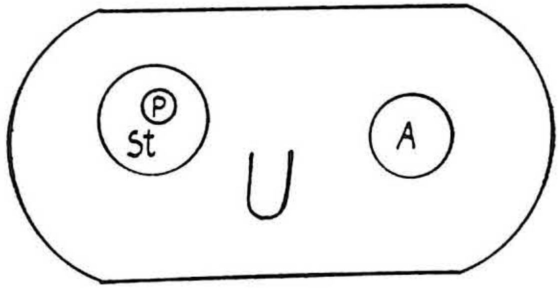

Figure 1

The stranger inquires and learns that street car D will bring him directly to his apartment. As the result of his first trip from the station to his home, some structuralization takes place: 'Direction from the station to the apartment' has become defined as using the street car D; the newcomer has acquired an impression of the distance between these points in the city. The street car made a number of turns. As a result, the newcomer is not very clear about the geographical position of both points. Still, he knows the direction in the sense of the 'path which can be taken' (Figure 2).

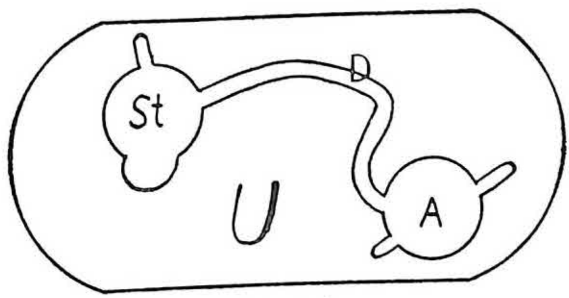

Figure 2

It may be that he has to start to work the very next morning. In this case, he might learn in a similar way the 'functional' relations between his home and the place of his work. But there will still be great areas of the city which are unstructured. Probably, at first an area geographically close to his home will become better known to him, and slowly the degree of cognitive structuralization will increase so that

finally he will know not only one path from his home to his work (W) or to the station, but several (Figure 3). He will know what is the direct route and finally he will be able to determine quite well the direction from any one place to any other in the city. He will know what the shortest route is for walking or for using an automobile or the subway.

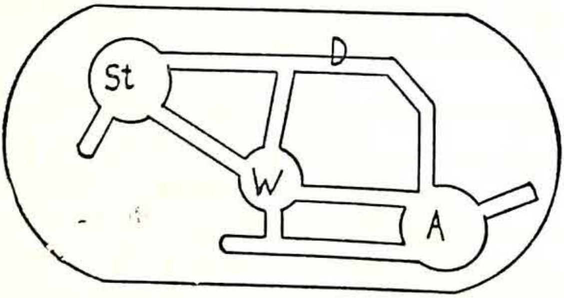

Figure 3

A similar process of differentiating previously undifferentiated areas will occur in regard to the social life of the city. In the beginning, it will be unclear in what direction socially the stranger moves in approaching a particular person. But more and more he will know who is who, how the social life of the city is structured, what are the direct and indirect ways, which social paths are easy and which are difficult to use. It is probably not necessary to elaborate the similar process of differentiation which occurs for the student who studies Greek history. Again, a previously vague and unstructured area becomes cognitively structured and specific.

Another example of this type of learning is the cognitive change of a psychological world as a whole during development. From all that we know, the newborn cannot distinguish between himself and his environment; slowly certain areas, for instance, those connected with eating, take on a specific character, become more and more differentiated; the parts of his own body become differentiated from each other and from the rest of the world; social relations develop and become differentiated; needs, emotions, language go through a similar process of differentiation (3, 6, 31, 56).

The concept of differentiation is a basic biological concept related to such fundamental and familiar biological processes as the subdivision of the egg into smaller units of more specific character. A shift

from the theory of association or conditioned reflex to a theory of differentiation (or similar changes in structure) means a change from a physical analogy (namely that of links in a chain) to a more biological approach. In addition, it seems to be easier to represent differentiation and other changes in structure in a mathematically precise way (3) than by the concepts used in the older theories. Associations, so far as they refer to changes in knowledge, may well be reinterpreted as relatively simple cases of change in structure.

2. Restructurization, Psychological Directions, Meaning

Not all changes of cognitive structure which we call learning have the character of differentiation in the sense of a subdividing of regions into smaller units. Sometimes a change in cognitive structure occurs without increase or decrease in the degree of differentiation. Classical examples are the detour problems (29). What is the difference between the psychological situation of the one-year-old child who cannot find the way to his goal when he stands within a U-shaped barrier (Figure 4a) and the four-year-old child who has no difficulty whatever?

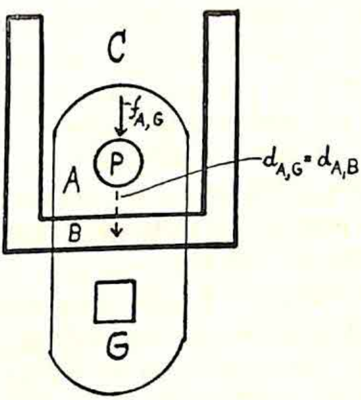

Figure 4a

To state this question in a different form: What psychological change occurs at the moment when the child has 'insight' into the solution for the first time?

The difference can partly be described as follows (38): Before the solution, the direction ($d_{A,G}$) from the region A where the child (P) is located toward the goal G is the same as the direction ($d_{A,B}$) to the barrier B ($d_{A,B} = d_{A,G}$). Moving in the direction C would at that time

mean for the child going in the direction ($d_{A,-G}$) 'away from the goal' ($d_{A,C} = d_{A,-G}$). The force $f_{A,G}$ acting on the child in the direction toward this goal leads, in this constellation, to a tendency to locomote in the direction $d_{A,B}$. As the restraining forces of the barrier B are too great, the child is unable to reach his goal.

After the insight (or when the child is old enough), the cognitive structure of the situation is changed (Figure 4b). The areas A and G,

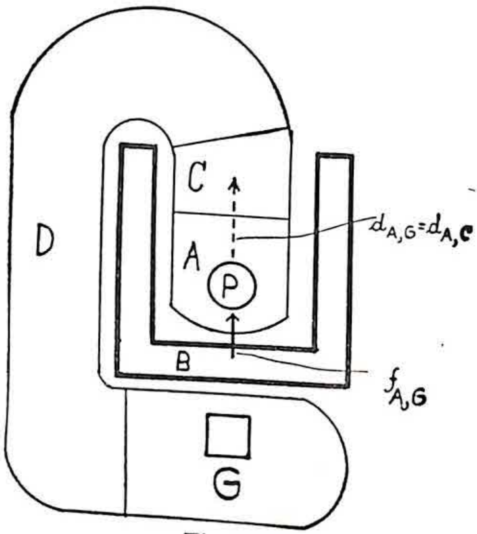

Figure 4b

which previously had the character of separated areas, are now connected as part of the area A, C, D, G. A locomotion from A to C may be seen as the first part of the path $w_{A,C,D,G}$. Correspondingly, the direction toward C ($d_{A,C}$) is now equal to the direction toward the goal G ($d_{A,G}$) rather than away from G ($d_{A,C} = d_{A,G}$; $d_{A,C} = d_{A,-G}$). The force $f_{A,G}$ leads now to locomotion from A to C, in line with this changed meaning of the direction.

This example illustrates how a psychological direction depends on the cognitive structure of a given situation. Behavior results from forces which have direction. Therefore, all behavior depends to a large degree on the cognitive structure of the life space. In an unstructured, or new situation, the person feels insecure because the psychological directions are not defined; in other words, the person does not know what action will lead to what result.

Learning, as a change in cognitive structure, has to deal with prac-

tically every field of behavior. Whenever we speak of a change in meaning, a change of such cognitive structure has occurred. New connections or separations, differentiations or dedifferentations of psychological areas have taken place. The 'meaning' of an event in psychology may be said to be known if its psychological position and its psychological direction are determined. In Mark Twain's *Life on the Mississippi,* the passengers on the boat enjoy the 'scenery,' but for the pilot the V-shape of the two hills, which a passenger admires, means a signal to turn sharply, and the beautiful waves in the middle of the river mean dangerous rocks. The psychological connection of these 'stimuli' with actions has changed, and therefore the meaning has changed.

One word about the problem of learning and repetition. One should be careful to distinguish the effect of repetition on motivation (see below) and on change in cognitive structure. It is correct that a change in cognitive structure may occur on the occasion of repeated experience. However, it is important to realize that it is not the repetition itself but the change in cognitive structure which is essential for learning If the newcomer has a map of the city, the number of trips from the individual's home to his place of work which is necessary for the creation of an adequate cognitive structure may be reduced to a few cases. According to Krechevsky (33) and others, even animals learn a maze by a series of changes in cognitive structure, called 'hypotheses.' The above analysis makes it understandable why gaining sufficient psychological distance from the problem and getting an over-all view of a broader area (29) are usually more helpful for creating that change of cognitive structure which corresponds to the solution of a task than repeating over and over again the same attempts. Recent experiments show that even in rote learning the number of repetitions is of secondary importance (19). Mere repetition, if carried on frequently enough, has a definitely opposite effect on learning. It leads to disorganization and dedifferentiation which are typical symptoms of what has been called psychological satiation (see below). As the result of the satiation, the meaningful will become meaningless and what has been known may be unlearned.

3. Time Perspective, Psychological Reality and Irreality

The behavior of an individual does not depend entirely on his present situation. His mood is deeply affected by his hopes and wishes (3) and by his views of his own past. The morale and happiness of an

individual seem to depend more on what he expects of the future than on the pleasantness or unpleasantness of the present situation. The study of prisoners (10), for instance, indicated that the amount of suffering in prison depends much more on their expectation of fair or unfair treatment in regard to their release in five years and their opinion of the fairness of their trial five years ago than on the unpleasantness of the prison activity.

The totality of the individual's views of his psychological future and his psychological past existing at a given time can be called 'time perspective' (15). In addition, one has to distinguish the dimension of reality-irreality within the psychological life space. The reality level of the psychological past, present, and future corresponds to the situation as they actually existed, exist, and will exist according to the individual's belief. Aside from his 'expectations' for the future, the individual has certain wishes or daydreams. The degree of discrepancy between the reality level and this irreality level for the future is decisive for what is popularly called 'hope.' It is basic for the security of an individual, for the process of planning, and for his productivity (3). Certain types of discrepancies between wish level and reality level in regard to the psychological past are the basis for the feeling of guilt.

During development, an enlargement of the time perspective takes place. The small child lives in the present; his time perspective includes only the immediate past and the immediate future. This smallness of time perspective is characteristic of what is usually called 'primitive behavior.' The time dimension of the life space of the child grows with increasing age; more and more distant future and past events affect present behavior.

Normal development brings with it, in addition, an increased differentiation in the reality-irreality dimensions of the life space. The young child does not very clearly distinguish wishes from facts, hopes from expectations (47). The older person is said to be better able to distinguish between daydream wishes and reality, although wishful thinking is certainly very common in adults, too.

Teachers and educators have been aware of the importance of time perspective as one of the fundamental aspects of development. 'Broadening the pupil's view' has always been considered one of the main purposes of education. Such an increase in time perspective can be viewed as one type of change in cognitive structure. There seem to be

no experimental data available on ways in which such a change can be achieved other than through normal development. This also holds for the differentiation of the life space in regard to its reality-irreality dimension, although educators have always stressed the importance of education for reality as a major task.

Some experimental studies indicate several conditions under which time perspective is narrowed and the difference between reality and irreality is blurred. An outstanding example is the 'primitivation' under emotional stress. It has been shown (3) that, in an insecure or frustrated situation, the productivity of a five-and-one-half-year-old child may regress to the level of a three-and-one-half-year old. This regression is partly caused by the decreased time perspective under those circumstances. Orphan children living under great social restrictions and meager opportunities show a much slower increase in mental age (and, as a result, a decrease in IQ), than children living under better conditions (51).

IV. Learning as Change in Valences and Values

In discussing the multitude of meanings attached to the term *learning*, we mentioned the following example: Autocracy is imposed upon the individual; democracy, he has to learn. It may be clarifying to discuss the meaning of the term *learning* in this sentence in more detail.

Learning democracy means, firstly, that the person has to do something himself instead of being passively moved by forces imposed on him. Secondly, learning democracy means to establish certain likes and dislikes, that is, certain valences, values, and ideologies. Thirdly, learning democracy means to get acquainted with certain techniques, for instance, those of group decision.

The last point does not need to be elaborated here because the problem of learning of techniques (in case one wants to have democracy) is practically identical with the problem of acquiring knowledge (i. e., change in cognitive structure, which we have already discussed) in combination with the problem of execution. The other two points will now be discussed.

1. Learning and Forces Imposed on the Person

Progressive education is accustomed to speak of the 'child-driven activities' as opposed to those activities which the child is compelled

to do. This points to a basic difference in motivation. Teacher, parent, or society frequently has to face the problem of an individual's having certain goals which he should not have or lacking certain goals he should have.

There are two principal ways to bring about the desired change. The one implies a change of the person's own needs or interests; the other leaves needs or interests more or less untouched, and compels the individual to do the undesired action either by direct force or by setting up a constellation where other, stronger, needs overbalance the effect of the first need.

Mere force plays a very considerable role in all education. The baby is not asked by the mother when it is to be taken out of the crib and when it is to be fed. The students are not asked for their consent in taking final examinations. We shall mention but a few aspects of this very basic question. (1) A great deal of difference exists in how gently or how forcefully mothers pick up their babies, and in how sensitively they observe those small indications of the babies' needs and desires. This question is closely related to the problem of the age at which education for democracy should start (35). (2) 'Learning' by force might take place when an individual is pushed into a situation and then 'adapts' himself to this situation. These methods are frequently used in politics and in education. To make a person behave in a way which he would resent, a step-by-step method is frequently applied—a procedure ingeniously employed by Hitler. The individual is pushed into a situation which is not sufficiently different from the previous one to create great resistance. After he has adapted himself, the next step is taken. Jerome Frank (14), in a study with students, has shown that such a step-by-step method is considerably more efficient in breaking resistance than the all-at-once method.

A method frequently used as motivation in learning is reward or punishment. The theory of association, or the law of effect, treats reward and punishment essentially as a linkage between a certain activity and a pleasant or unpleasant tone. To predict the actual behavior, one has to see that reward and punishment are psychologically something more specific. An analytical treatment of the typical situation of the threat of punishment, for instance, shows the following constellation. The individual dislikes the activity 'T' (Figure 5). To make him carry out this activity, a second even more disagreeable

possibility is set up in such a way that the individual has to face one of them. In other words, the individual is in a particular type of conflict situation, namely, in a conflict between two forces ($f_{P,-T}$ and $f_{P,-Pu}$) away from two disagreeable areas. It can be shown (38, 40) that such conflicts lead to a tendency to "leave the field" (1), to run away from both activities. To make the threat of punishment effective, barriers (B) against this way out have to be established—barriers

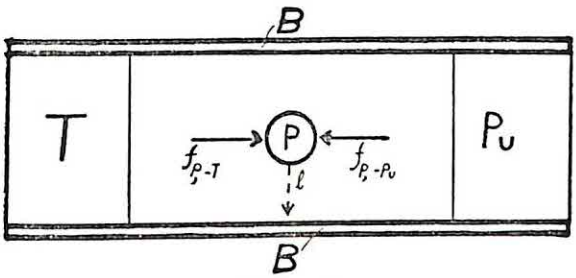

Figure 5

strong enough to keep the individual within the conflict area. These barriers usually consist of social forces imposed upon the individual by an authority. By detailed analysis of the field in case of threat of punishment, one can derive the tension resulting from the conflict, the tendency to fight the authority, and a variety of other factors. It can also be shown that the space of free-movement has to be sufficiently narrowed down, that a somewhat prison-like situation has to be created if the threat of punishment is to be effective.

Neither the promise of reward nor the threat of punishment creates the same constellation of psychological forces as a change of interest in the demanded activity itself. Nor is the difference between reward and punishment merely that of attaching a pleasant or unpleasant tone to an activity. The promise of reward does not require a prison-like situation and this permits more freedom to the individual (38) in other directions. Still, a barrier has to be kept up around the reward in such a way that the goal cannot be reached save by the way of the disliked but requested activity. It may be mentioned that reward in the end may lead to an actual change in interest, so that the originally disliked activity may become liked. The repetition of punishment usually makes the demanded activity only more hated. However, a state of apathy and giving-in may be reached, as shown by experiments on social climates (43).

2. Changes in Valences and Values

a. Changes in Needs and Meaning.—Anyone who wishes to influence likes and dislikes has to be aware of the changes of valences which take place with the changes of needs in the process of satiation or during development. The individual may be attracted by an activity like drawing or dancing or going to the movies. If he follows this desire long enough, a change in attractiveness results. As in physical consumption, the psychological 'consumption' of the activity satiates the underlying need. Experiments have shown that repetitions beyond the satiation point lead to variation, inattentiveness, mistakes, fatigue, and finally to a complete disorganization; in other words, to an 'unlearning' in the sense of inability to carry out an activity previously mastered (26).

Frequently, 'learning' to like or dislike certain activities is the result of the long-range change of needs which takes place during development and seems particularly marked during the so-called crises, such as adolescence. Oversatiation, too, may lead to a permanent dislike for an activity.

It has been one of the fallacies of classical behaviorism to describe the character of an activity by its physical aspects only and to neglect the great effect of the psychological setting. The experiments on satiation (26) clearly indicate that moving the arm in an identical way by making certain lines may have very different psychological and physiological effects, according to the meaning of this activity. For instance, making a pattern of four lines may have become disintegrated and the arm fatigued as a result of oversatiation. A change to a different pattern of lines, or to making a picture from these lines, suffices to wipe out the bodily symptoms of fatigue and to bring about reorganization of the activity. To write a paper containing hundreds of letters does not mean repetition and therefore does not lead as quickly to satiation. This is one of the reasons why the method of writing and reading by learning sentences or words is superior to the older method of learning letters. The modern primer uses stories which 'progress' although they are composed of relatively few words and elements. In this way, positive motivation for learning to read is created or set up.

The valence of an activity depends partly on its meaning and therefore on the cognitive structure. For instance, a child who dislikes a certain food at home may show no such dislike when getting the same

food at a friend's party. The most frequent method of changing valences in education is based on this relation to cognitive structure. For instance, the mother may try to eliminate a certain behavior by remarking that only "bad children do that"; she may induce the unwilling child to eat by saying, "One bite for papa, one bite for mamma, and one bite for baby." Food preferences in children can be changed by telling a story in which the disliked food is a favorite for the hero of the story (9).

The relation between cognitive structure and valence is less obvious in cases like those where children continue to dislike food when eating it at home even though they don't mind eating the same food at the nursery school. For these children, coming to the dinner table at home has acquired the meaning of going to a fight with mother. These old 'habits' can be changed from one day to another if it is possible to change the meaning of the activity (55). It is easy to make an adult do something in a medical setting or as a subject in a psychological experiment (14) which he would definitely refuse to do outside of the experimental situation.

The relation between cognitive structure and valence is particularly striking in what is called 'cultural differences.' Cultures are not only different in regard to what values are recognized; at least as important is the way different activities are seen as linked. For Mennonite children in Iowa, for instance, work and religion are much more closely related than for non-Mennonite children in comparable rural areas (25). Much of advertising and most of propaganda are effective not by changing needs and values as such but by changing the cognitive structure in a way which makes the propagandized activity appear to be a part of, or a means to, an area which has high value for that individual.

'Learning' of new ideologies, in other words, conversions, are usually difficult to bring about partly because of the way in which needs and cognitive structure are interwoven. An example of a successful change in ideology and social behavior is the retraining of relatively autocratic recreation leaders into excellent democratic leaders, as carried out by Bavelas (4). These leaders had followed their method of handling groups for five to seven years. The change took place within three weeks. It was brought about partly by observation of other leaders and a detailed discussion of the various possibilities of the leader's reactions to a multitude of situations arising from group life.

In this way, the cognitive structure of the field 'leader behavior' became much more finely differentiated; the individual became sensitized. The motivational change from skepticism to enthusiasm for democratic procedure cannot be discussed here in detail. It came about, in part, through the thrill of experiencing what a democratic group-life can do to children, and through the realization that one is able to create such an atmosphere. The preceding years had been for these people a period of low morale, of dissatisfaction with the insecure position of the W.P.A. recreation worker and the carrying through of their work as a matter of routine. The new experience could change the ideology and morale of these people so suddenly and deeply because it provided worth-while goals and a long range outlook to individuals who previously had lived with a time perspective which was composed of a disagreeable past, unsatisfactory present, and no positive outlook for the future. In other words, the retraining was achieved, not in spite of the long-standing bad habits but, partly, because of them.

The problem of time perspective is closely related to certain changes in valences or goals which depend on the level of aspiration.

b. Learning and the Level of Aspiration.—The level of aspiration is defined as the degree of difficulty of the goal toward which a person is striving. Whether or not a person will learn a certain activity is deeply influenced by his trying or not trying to do so. Therefore, the factors which determine the level of aspiration are of basic importance for learning.

The level of aspiration is influenced partly by the ability of the individual as manifested in his past and present successes and failures (17, 21, 24), partly by certain group standards (12, 17, 20, 44). By and large, the experience of success and failure occurs only in a relatively limited area of difficulties which is close to the boundary level of ability of the individual. Success and failure influence the expectation for the outcome of the future action and raise or lower the level of aspiration accordingly. However, this 'rational' factor is by no means the only one determining the level of aspiration. A child below or above the average of the group may permanently keep his level of aspiration too high or too low for his ability. It has been shown (12) that the knowledge of one's own or others' group standards affects the reality and the wish level, depending on the degree to which these group standards are accepted.

Good students tend to keep their level of aspiration slightly above their past achievement, whereas poor students tend to show, relative to their ability, excessively high or excessively low levels of aspiration (50). In other words, the poor students have not learned to be 'realistic' in evaluating success and failure for their goal setting. Failure frequently leads to rationalization, emotional outbreak, overpersistency, or rapid discontinuance (17, 28). It has been shown that children who had the tendency to react to failure by quitting, by rationalization, or by emotional outbreak can learn to react more maturely to such failure (28). This 'learning to take it' is certainly one of the most important aspects of learning as a part of the character development of the individual.

V. Summary

This brief survey of problems related to learning has not attempted to deal with the difficult questions of learning in the sense of voluntary control of the motoric (which would include such matters as self-control, handling of mechanical or social 'tools,' such as speech, and 'action through a distance'). An important approach to the latter is contained in Heider's theory of "thing and medium" (18). The dynamics of these processes seem to be guided by a type of 'organizational interdependence' (3) similar to the relation between leader and led or between the so-called higher and lower nerve centers.

Summarizing our discussion from a more dynamic view, we might say: we have distinguished learning in the sense of change in cognitive structure from learning in the sense of change in motivation.

1. Change in Cognitive Structure

A change in cognitive structure may occur in any part of the individual's life space, including the psychological future, the psychological present, or the psychological past. It may occur on the reality level or on the irreality level (wish and fear level) of each of these sections of the life space.

Establishment or severance of the linkage between two regions of the life space, with which the theory of association or conditioned reflex is mainly concerned, is only one type of structural change. A basic change in structure, both for learning and for long range development, is the differentiation of previously undifferentiated regions.

According to field theory, all changes are due to certain forces (directed entities). In regard to the forces which bring about a change in cognitive structure, it is convenient to distinguish two types: one resulting from the structure of the cognitive field itself, and the other from certain valences (needs or motivations).

a) The first type of forces leading to change in cognitive structure is very similar to, if not identical with, those forces which govern the perceptual fields. They must be considered when discussing problems of figure and ground, of specific patterns and their internal equilibria (57). We should get accustomed to include within perception psychology also the perception of the character of other persons and of social facts. There are a number of indications that the laws which determine the patterning in perception are more or less the same as those in thinking and memory. [One should, however, be warned against too simple an approach. For instance, three developmental types of cognition are distinguished by Vigotsky (54): situational thinking, classification, and thinking in theoretical terms. Similar distinctions are much emphasized in psychopathology (16).]

b) In addition to the forces resulting from the cognitive structure as such, the cognitive structure is deeply influenced by the needs of the individual, his valences, values, and hopes. These forces play an important role in the solution of any intellectual task. In fact, a psychological force corresponding to a need can be said to have two basic results. It leads either to locomotion of the individual in the direction of the psychological force or to a change of his cognitive structure in a way which corresponds to such a locomotion or which facilitates it. Therefore, all intellectual processes are deeply affected by the goals of the individual. We have seen that intellectual processes, which can be viewed as one type of productive activity of the individual, depend upon his emotional state, that is, the tension, the degree of differentiation, the size, and fluidity of the life space as a whole. It is a corollary of the relation between cognitive structure and perception that perception, too, is dependent on the needs and emotions of the individual. The 'projective' techniques (46) of studying personality are making use of this relation.

2. Change in Motivation

Learning as related to change in motivation deals either with a change in needs or a change in the means of their satisfaction. To these

processes belong not only such examples as becoming addicted to or breaking away from a drug habit, and any ideological conversion, but also the normal process of acculturation during childhood or after entering a new social group. Obviously, forces governing this type of learning are related to the total area of factors which determine motivation and personality development. We have mentioned here but a few—the basic laws of needs and satiation, goal structures, the level of aspiration, and the problem of group belongingness.

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CHAPTER VII

RECONCILIATION OF LEARNING THEORIES

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I. How Differences in Learning Theory Have Arisen

The authors of the preceding chapters on theories of learning have couched their ideas in specialized and somewhat unique terminology. Many of the terms they have used are virtually 'fighting' words in the literature of the field, such as "insight," "trial and error," "field," "element," "configuration," and "connection"—terms which symbolize the conflicts between systematic points of view. In the controversial psychological literature, however, many of these conflicts have been magnified out of all proportion to the essential or real differences in theoretical positions. In fact, these specialized terminologies which seem, on the surface, to make one position distinct from another, often conceal rather striking examples of consistency in underlying observations and descriptions of learning behavior. Nevertheless, the theories which have been outlined in this section do differ in certain general characteristics, at least in emphasis or degree. Before pointing out the fundamental similarities in the several points of view, it may be worth while to suggest how these differences have arisen.

1. Effect of Different Kinds of Tasks to Be Learned

a. Differences in Amount of Discovery of Correct Response. One reason why accounts of learning differ is that experimenters have set different kinds of tasks for their subjects to learn. Learning situations, for example, differ in the extent to which the subjects must *discover* the correct response (30). These differences can be arranged along a continuum, for it is probable that most learning situations call for some degree of discovery of the appropriate reaction or reactions. At one end of the scale is what is known as rote learning, such as memorizing a list of nonsense syllables. The element of discovery in this sort

of task is at a minimum. The traditional simple conditioning experiment, in which one situation is substituted for another in evoking a given response, is another case in which the subject does not have to find a solution. The necessary features of this sort of conditioning have been outlined as follows (16, p. 27): (1) an unconditioned stimulus capable of eliciting a regular response, (2) a conditioned, or substitute, stimulus not originally capable of producing the unconditioned response, and (3) repeated presentation of the conditioned and unconditioned stimuli together in a certain manner until the substitute stimulus evokes the original unconditioned response without the occurrence of the unconditioned stimulus. On the many occasions in which the teacher has merely identified the situation for the pupil, prescribed the response, and directed him to repeat the two together, the classroom has practically duplicated the kind of laboratory situation in which discovery is an inconspicuous feature.

When the individual meets a complicated problem, on the other hand, the role of discovery is extremely important. In the problem situation, the subject confronts an obstacle to the attainment of his objective, and finds that his previously acquired modes of response do not provide a solution. Then the discovery of the appropriate reaction pattern is the critical feature of the learning process. This is true not only in verbal reasoning, but also in the acquisition of skill, which demands the selection and organization of movements necessary for successful performance. Here again, the important features of the learning process are (1) how the appropriate responses occur in the first place, and (2) how the individual recognizes their appropriateness. These are factors which are involved in the discovery of the adequate behavior pattern.

It is obvious that the most conspicuous characteristics of behavior differ considerably between situations calling for minimum and maximum amounts of discovery. In the classical conditioning experiment, variability of behavior is probably the least prominent feature. There are also a good many classroom learning activities in which variation of behavior must be held to the minimum. For example, the child practicing his spelling words is expected to repeat the same sequence of letters again and again. But in working out a rational learning problem, in learning to drive in golf, or in solving a problem in geometry, the amount of variability in the subject's behavior is likely to become impressive. He explores; manipulates; tries this response, dis-

cards it, and tries another. The conspicuousness of these trials, or successive attempts at solution, has led many observers to describe learning as a trial-and-error process, or, more appropriately, as a process of approximation and correction (30).

Other observers have paid less attention to the extent of the trials and more to the moment of solution. In some instances, they have found that the appropriate behavior was selected and organized gradually, and in other cases they have noted that the solution, fully organized, occurred suddenly, although it was sometimes not very smoothly executed at the first appearance. The organization of behavior appropriate to the organism's goal has been defined as 'insight.' The observation of learning activity in complex problem situations has enabled psychologists to study the insight phenomenon. This feature of both animal and human behavior is much more difficult to detect in conditioning experiments. It is equally hard to identify in those classroom situations in which the pupil must memorize a series of verbal statements which are not intelligible to him (such as committing to memory definitions which he does not understand), or master a series of procedures without grasping their rationale (such as learning the steps in working arithmetical exercises without understanding their mathematical relations).

What behavior will occur when an organism learns is a function both of the nature of the organism and of the character of the situation which evokes the learning activity. If one consistently places one kind of task before his subjects, he will observe certain forms of adjustive behavior. If he regularly presents another and very different sort of situation, he may evoke other forms of learning activity.

b. Differences in Difficulty of the Task. Closely related to the amount of discovery necessary in learning is the difficulty of the task, which is another condition that determines, in part, the characteristic features of learning. Gestalt psychologists have contended that many learning experiments have presented the subjects with tasks so difficult and so far beyond their level of maturity that they could not grasp the essential relationships in the problems. The only thing the subjects could do under such circumstances was to resort to typical trial-and-error behavior. The more difficult the problem and the less relevant the subjects' previous experience, the less well directed and organized (or the more random) these successive attempts would be. Other psychologists, however, have countered that the Gestalt experi-

ments usually erred in the other direction by presenting tasks which were simple enough and sufficiently similar to ones the subjects had previously learned for them to react appropriately and quickly on the basis of past experience. What seemed to the Gestalt psychologists to be sudden flashes of insight, therefore, could be subsumed under transfer through identical elements (20).

When the task is difficult for the subject, the essential clues or subtle features of the situation are likely to be embedded in the gross structure and difficult to discriminate. When the task is easy, the similarities with previous experience and the constituent relationships are more readily perceived and the appropriate behavior is more rapidly organized. Thus the rapidity with which the correct responses are discovered and utilized, and the incorrect ones eliminated, depends upon the difficulty of the task for the subject. If the task is especially hard, the observer will be impressed with the gradualness of learning. If the problem is correspondingly simple, the experimenter will be struck by the suddenness of the solution and may conclude that immediate insight is the fundamental feature of the learning process.

c. Differences in Degree of Organization in Material to be Learned. The dependence of the learning process upon the nature of the situation can be illustrated in terms of another continuum. The tasks to be learned may vary from those which possess very little structure to those which are highly organized. One example of this range of organization was presented in the four lists of words in Hartmann's chapter on field theories of learning (p. 188). Such series may range from a mere collection of discrete items to those in which there is a highly coherent, 'tight' scheme or form which establishes an intrinsic relationship among the members of which it is composed. This difference in degree of organization can also be illustrated by series of numbers. This series, for example, possesses relatively little structure, except that the numbers are arranged in ascending magnitude: 2, 3, 7, 10, 19, 24, 29, 32, 48. The following one, however, is built according to a definite scheme: 5, 6, 8, 11, 15, 20, 26, 33, 41 (15). If the learner discerns the scheme of a structured series, he will almost certainly learn it more quickly than he will an unformed series. But he will not only learn it more rapidly, he will use somewhat different procedures. Again, the observer's description of learning will be a function of the nature of the task and of the subject's recognition or lack of awareness of the organizing principle of a structured situation.

Much of the early research on human learning was conducted with nonsense syllables, or other kinds of relatively unorganized and meaningless material, and the same subject matter is still extensively used. Many descriptions and interpretations of learning, therefore, have been derived from what the layman would characterize as purely mechanical activities. As a matter of fact, it has been shown that lists of nonsense syllables are unfavorable to effective learning, not only because they lack the relationships of meaningful material but also for the reason that it is difficult to discriminate clearly one item from another. A list of nonsense syllables constitutes what has been called 'homogeneous' material—all of the same kind—in which it is hard for each member to retain its individuality (24, pp. 482-89).

Many conclusions about learning have also been drawn from multiple-choice situations in which the 'correct' response to the stimulus was arbitrarily designated by the experimenter and did not 'belong' to the stimulus in any meaningful or intrinsic fashion. Thus Thorndike (37) reports an experiment in which his subjects were given a list of nonsense words each followed by four English words, one of which was supposedly related to the stimulus word. The subjects were asked to guess the correct response, which had been arbitrarily chosen in the design of the experiment. The learning was done with a 'vanishing situation.' The subjects were given a stimulus word, made a guess, and were told 'right' or 'wrong' and sometimes given some kind of reward or punishment. Then they were immediately given the next stimulus word, with an opportunity to make one guess, and so on throughout the series. One of Thorndike's students (39) afterwards studied learning in the 'retained' situation. The material was somewhat different, but the 'correct' associations again were arbitrary rather than functional. In the second experiment, however, the stimulus was retained in each instance until the subjects had guessed the correct response. Both experiments revealed that the incorrect responses, when punished by the announcement of 'wrong,' a money fine, or an electric shock, were more rather than less likely to recur in spite of the annoying aftereffect. As a result of these and related experiments, Thorndike came to the following conclusions:

> The attainment of active rather than passive learning at the cost of practice in error may often be a bad bargain. Refusal to supply information on the ground that the learner will be more profited by discovering the facts by himself runs the risk not only of excessive

time-cost but also of strengthening of wrong habits. The learner's self-punishment when he makes a mistake may sometimes be no better than the punishment in our experiments (37, p. 147).

The experimental results are evidently sound, and it is possible that the rather sweeping conclusions quoted above are equally valid. But apparently the results of multiple choice learning in which the correct responses were arbitrarily rather than meaningfully determined were generalized to cover meaningful as well as rote learning. One may justifiably question the extension of results secured in one type of experimental situation to others which differ greatly in character, without verifying such applications by appropriate investigations. At face value, Thorndike's conclusions and admonitions seem to throw considerable doubt upon the soundness of our recent emphases on active exploration and discovery and self-directed learning, particularly when such activities produce initial errors. There is very good reason to believe, as Thorndike does, that learning proceeds most expeditiously when the emphasis is upon positive measures and appropriate responses. But we also have evidence that it is often not productive in guiding learning to designate the correct responses and conduct the learner through these reactions. The learner's own initiative is an important element in successful adjustment. Melton has pointed out (30) that "the important contribution of Carr and his students to this aspect of the process of learning is that active and individual discovery of the adequate response is a necessary part of the fixation and perfection of the adequate response and the elimination of inadequate responses." We also have evidence that active discovery is more productive than authoritative identification in the learning of the simple number combinations (28, 36). Investigations of the test-study-test method of learning the spelling of words have revealed that initial errors on the first test over new words do not tend to persist when pupils make an active attack on them in subsequent study periods. Before final conclusions are reached concerning the persistence of errors which occur through active discovery, experiments are needed with meaningful tasks as well as with the acquisition of arbitrary associations. An inclusive psychology of learning must rest upon a wide range of types of learning situations.

The learning which children do in school probably varies almost as greatly in degree of meaningful organization as the tasks which sub-

jects learn in the psychological laboratory. For example, some words are spelled phonetically, and so constitute a logically structured situation. Other words are not wholly phonetic, and so possess an organization which depends on little more than a spatial-temporal pattern. Some punctuation rules probably seem to the child to be arbitrary conventions, but other punctuation situations depend clearly on meaningful relationships. For example, the presence or absence of the comma in the following sentence makes it convey different meanings: *Take the collar off, Peter.* The relationship of parts of a sentence also depends upon the meaning intended. The following sentences say different things: *I saw the house coming around the corner. Coming around the corner, I saw the house.* When punctuation and the arrangement of parts of the sentence are determined by the meaning to be expressed, the situations may be said to possess a high degree of structure or organization.

While a greater or lesser degree of organization may be inherent in some of the things it is desirable to learn, the factor of organization in most educational situations can be controlled to a considerable extent. For example, one can teach the number combinations as highly specific and discrete items, or present them in orderly arrangements, or group them according to a principle. Thus the idea of adding zero to a number could be explained as a means of learning the zero-combinations as a group. It is possible to teach fractions, percentage, and decimals as essentially unrelated processes, or to show the pupil that they are really different ways of expressing and manipulating the same number relationships. History, too, may be taught and learned as a compilation of facts with little more relationship than that provided by chronological sequence, or this information may be organized to show the development of institutions and ideas. Because learning situations in the laboratory and in the school differ greatly in the extent to which they are structured or meaningfully organized, descriptions of how human beings learn may be expected to vary with the nature of the task with respect to which the observations are made.

2. Effect of Ascribing Causal Significance to Descriptive Terms

Science aims at full and accurate description of observed phenomena. But it does not merely catalog events or note detailed characteristics of the occurrences it investigates. The fundamental purpose of science

is to discover some kind of order in these events or specific conditions. It looks for relationships among the phenomena which have been observed. It proceeds, also, to discover common elements in these specific happenings, "so that the endless variety of phenomena may be viewed as a system in which structure is exhibited" (6, p. 396). In other words, it is essential to reduce a great mass of observational data to more general principles which are capable of subsuming a large number of specific instances or concrete cases. When these principles take the form of a coherent set of postulates, a systematic theory has been developed. In the development of a science, as Hull explains:

> There gradually accumulate a body of observations, on the one hand, and simultaneously a parallel body of ideas or interpretations of these observations, on the other. Thus, even from the very first, scientific development has involved an intimate interaction between observations and ideas. Actually, observations give rise to ideas, and ideas lead to further observations. The orderly arrangement of the observations constitutes the empirical component of science, and the logical systematization of the ideas concerning these observations constitutes the theoretical component (19, p. 1).

Principles and theoretical postulates may take several forms. A principle may represent 'the one in the many,' or the 'identity amid differences.' In other words, it may be the result of abstracting and generalizing the common element or pattern in a series of observed phenomena. Or, a theoretical postulate may be expressed in terms of certain supposedly more fundamental and underlying factors (6, pp. 397ff). An example of the former type of theoretical principle in psychology is the generalization that learning in certain types of situations may be looked upon as a series of progressive approximations to some standard or goal of performance. An illustration of the second type of theoretical principle is the effort to refer specific forms of behavior to the operation of underlying neurological processes (21, pp. 27, 38, 89).

Scientific explanations are essentially the systems which are devised for the purpose of ordering and predicting empirical data (29). For this reason, it has been said that explanation is really description at a different level—a more penetrating or a more generalized level. "The more one inquires into explanations, the more one finds them to consist simply of further descriptions" (13). This is an important point to emphasize in connection with psychological theory,

for the layman, at least, in reading systematic psychology may ascribe causal significance to what are really descriptive categories. Although such terms as 'frequency,' 'trial and error,' and 'insight' are descriptive expressions, they have often been loosely used to designate 'forces which can do something.' One frequently hears such phrases as 'learning *by* trial and error,' or 'learning *by* insight,' as if 'trial and error' and 'insight' were forces, causes, or magic agents which could be put to work to produce desired changes in behavior. Actually, when one says that learning proceeds by trial and error, or by approximation and correction, he is describing, in terse language, what usually takes place when the organism confronts a difficult problem situation which places an obstacle in the way of gratifying a need or attaining a goal. One may define insight, as Hartmann does, by saying that it "connotes appropriate behavior in the presence of any life-situation," or by calling it "the internally apprehended correlate of the 'closing' of an incomplete configuration." But whether the term is defined simply or with a flourish of special terminology, it is essentially a descriptive summarization or generalization of certain manifestations of the learning process. The educationist, looking to the 'new psychology' for justification of his educational gospel, is especially prone to turn such concepts as 'insight' into causal agents. But unfortunately, this tendency is not confined to laymen. Psychologists themselves, though at one point stressing the descriptive character of their science, may at another point slip into the language, if not into the mental set, of explanatory causation. While this may not confuse the careful psychologist, it may mislead the layman. In any event, the imputation of causal agency to descriptive terms tends to make the several theories of psychology appear more conflicting than they are. Thus 'the trial and error theory of learning' seems to be sharply set off from the 'insight theory,' if one is to trust much of the educational and some of the psychological literature.

As a matter of fact, the terms 'trial and error' and 'insight' both roughly describe certain phases of the learning process and fail to describe other aspects. In general, what the one emphasizes, the other neglects. Actually, the behavior which is popularly called 'trial and error' and that which is said to represent 'insight' are not entirely disparate, but have certain important relationships. Although sudden appearances of a correct solution are the most dramatic instances of insight, the Gestalt literature now recognizes degrees of insight. It can be *partial*

or *complete, gradual* or *sudden*. The curves of learning which represent partial and gradual insight leading ultimately to full comprehension of the problem, or to complete organization of the response, will look very much like the curves which depict the gradualness of learning so characteristic of the 'trial and error' accounts. There are other relationships between so-called trial-and-error behavior and insightful solution which will be discussed later in this chapter. When the functional relationships between these two phases of learning are understood, they will be seen as complementary, rather than diverse descriptions of learning. When either 'trial and error' or 'insight' is used as a causal factor, the distortion becomes more serious, and features which are really related become symbols of supposedly distinct learning theories.

3. Effect of Emphasis on Certain Features of Learning to the Exclusion of Others

a. Emphasis on 'Wholes' or on 'Parts.' It has been suggested that each theory of learning has emphasized some phase or feature of the learning process to the subordination or exclusion of other aspects (22). The association psychologies, for example, have emphasized the analysis of the gross features of learning into constituent processes. The organismic and Gestalt accounts of learning, on the other hand, have put more stress upon the structural or field properties of experience than upon its parts. "Their insistence on the whole being more than the sum of the parts," charges Sandiford, "while true, has led to a shocking neglect of the parts." This statement, of course, may be more applicable to some exponents of field theory than to others. On the other hand, association theories of learning have paid too little attention to the organization of behavior. Sandiford observed that "connectionism takes the organism for granted." Too often, some principle of 'organicism' is stated, but soon forgotten in the description and interpretation of behavior. We may reasonably conclude, with Dashiell, (10) that "psychology has given only lip service to the idea of man-as-a-whole." Perhaps Thorndike himself did not discount the importance of organization, yet he did not constantly reiterate it. Gates quotes him to this effect: "The reason why I have said much about frequency of connection, satisfyingness of connections, identifiability of situations, availability of responses and the like, and little about the purposes or mental sets or total minds which direct and organize them is not

that I belittle the latter. It is rather that the general importance of the latter is obvious." But the significance of directional and organizing tendencies was not patent to many persons who read Thorndike and tried to apply his principles of learning to educational problems.

When Thorndike began to experiment with problems in the learning of school subjects, *analysis*, a certain kind of it, at least, was badly needed. As Sandiford pointed out, "Before connectionism affected the school, fractions were taught in one step and the pupil was expected to make the deductions necessary in solving his particular problems." Arithmetic was highly condensed and generalized. Breaking up such broad 'mental functions' as long division into component bonds or connections and hierarchies of these constituents—'unit skills' and 'lesser abilities'—undoubtedly provided the basis for a better control of arithmetical processes. It is conceivable that making an inventory of the specific phases of a general process like long division (such as the several combinations in which zero could occur in the divisor, dividend, and quotient) *might* have facilitated the understanding of the division operation. But unless these variants of the process were consciously used as a means of identifying and generalizing the basic principles involved, there could be no certainty that an understanding of the operation would emerge. Furthermore, in what Gates would consider to be perversions of connectionism, an overemphasis on the specificity of learning took root. In some instances the constituent connections into which a function had been analyzed were, according to Sandiford, imparted to the learner "one by one . . . and endless practice insisted upon." The formula became: Teach A, drill A; teach B, drill B; drill A and B together. The practical result of excessive analysis in arithmetic was to obscure the fundamental mathematical relations which govern the number system. As a reaction to these tendencies, there is a movement now to emphasize meaningful learning and generalization in arithmetic as a means of controlling specific number situations (33). In view of the widespread neglect of system and understanding in learning, it is fortunate that Gates has made explicit and dominant the factors which Thorndike thought were obvious—the role of relatedness, the importance of mental set and purpose, and the organizing and directing function of goals. Wholes and parts are both significant aspects of behavior and should not be divorced in considering the learning process.

b. Emphasis on Differentiation or Integration. Other differences

in emphasis must be summarized more briefly. Some descriptions of learning have stressed the differentiation of behavior, which is the emergence of details or specific aspects of behavior from a more generalized whole. In certain variations of organismic and Gestalt psychology, the principle that growth proceeds in direction from whole to part, from general to particular, has been accepted as the fundamental and pervasive concept (41). Associationism, on the other hand, has emphasized the integrative or synthetic aspects of learning. Actually, both differentiation and integration occur in human growth and in human learning (3).

c. *Emphasis on the Present Situation or on Past Experience.* It has been said that certain theories of learning have accentuated the structure of the present situation in inducing behavior which is appropriate to it. Such an emphasis will be found in Lewin's discussion of the field theory of learning in chapter vi of this volume. Other theories, including associationism, have emphasized the effect of the organism's previous experience in interpreting the present situation and responding to it. Some formulations of learning have seemed to slight the organism in the behavior sequence, again putting pronounced stress upon the power of a situation to evoke a response which had been inherited or connected with it through practice. But most descriptions of learning have made the organism play a leading role through the operation of drives, sets, interests, attitudes, purposes, or determining tendencies of some sort. Certainly all the theories of learning outlined in this Yearbook have made some place for the organism, though some of them have given it a more dominant place than others. A full description of learning, and a reliable prediction of subsequent behavior must cover all three factors—situation, organism, and response.

d. *Emphasis on Intellectual or Emotional Factors.* Some treatments of the learning process have given almost exclusive attention to so-called intellectual activities, depending upon symbolic and abstract processes. Other approaches—the Freudian one most spectacularly—have concentrated upon the emotional forces in learning. There is now a tendency to investigate the interrelationships among the several phases of human development. Genetic studies of behavior have done more than anything else, perhaps, to focus attention on the all-round growth of the child and the interdependence of symbolic, emotional, and social behavior.

4. Summary

We have explained how descriptions of learning depend on the types of situations which are placed before the organism. We have pointed out that these situations may be arranged along continua which represent (1) differences in the amount of discovery of the correct response made necessary by the situation, (2) differences in the difficulty of the task, and (3) differences in degree of organization in the learning situation. We have also illustrated how different phases of a total learning process may be singled out for particular emphasis. This kind of analysis of the learning process has led certain psychologists to conclude that there may be several kinds of learning, each of which has its own set of principles. Tolman, in fact, has listed as many as seven varieties of learning with their related 'laws' (38). However, instead of positing many discrete kinds of learning, it may be more useful to suppose that principles of learning themselves constitute a kind of continuum. Certain principles may suffice to explain simple forms of conditioning in which one stimulus is substituted for another in evoking a response. In such instances, contiguity seems to be the principal condition among those necessary for learning to occur. In other forms of learning, usually called instrumental conditioning, the experimenter waits until the appropriate response occurs for one reason or another, and then reinforces it with a reward. And so principles concerned with reinforcement through 'effect' come into play. Finally one reaches learning activities in which elimination, selection, and organization of responses become the characteristic features, while mental sets, anticipations, goals, and purposes, often expressed in verbal form, add further complexities. This calls for an expansion of the description of learning, and the extension of basic principles.

All of these forms of learning occur in human beings. All of them occur in both children and adults. Furthermore, it is difficult to separate even such a complex process as problem solving or reasoning entirely from the more familiar forms of conditioning. Even though one might hesitate to explain problem solving entirely in conditioning terms, he would nevertheless recognize the phenomena of conditioning in some phases of the process. But with the present state of experimental knowledge, it scarcely seems wise, even to some of those most closely associated with conditioned-response psychology, to try to reduce complex forms of learning to known principles of conditioning (16). It may

be just as disadvantageous at the moment to try to classify all forms of learning under configurational or 'trial-and-error' types, as has been suggested could be done (22). It will probably be more instructive for the present to observe and describe accurately and in considerable detail the activities which occur in a great variety of learning situations, and to formulate for these learning processes the principles which seem necessary to cover the essential events. This probably means that for the time being we cannot reduce all cases of learning to a very few principles (such as the known principles of conditioning or the present rubrics of 'insight psychology') even though that ultimately may be possible, but must retain a fairly extensive set of principles to cover a wide variety of learning situations. At least, such a program seems more promising to the educational psychologist who is responsible for developing principles of guidance for educational activities.

II. Synthesis of Learning Theories

Although differences of emphasis and degree exist among theories of learning, a great deal of commonality can be found among them. Furthermore, although certain phases of the learning process, such as goal-behavior, have a different *systematic* significance from one theory to another, they may point to approximately the same *practical* consequences. We shall turn now to a survey of the similarities in the theories of learning outlined by Guthrie, Hull, Sandiford, Gates, Hartmann, and Lewin.

1. Both Situation and Response Are Complex and Patterned Phenomena

Gestalt psychology, which has been constructed to a very great extent upon experiments in sensory perception, has made a special point of the fact that the stimulus field to which the organism responds is always structured. In other words, the response is not to isolated points or items or stimuli, but to a pattern of such events. Gestalt theory, according to Woodworth, "uses the concept of the dynamic field, all parts of which are interacting from the moment of peripheral stimulation. The forming process is coincident with the receptive process" (43, p. 624). As Koffka puts it, "Our reality is not a mere collocation of elemental facts, but consists of units in which no part exists by itself, where each part points beyond itself and implies a larger whole" (24, p. 176). The perceptual response which the organism

makes to such a stimulus pattern is also organized at the time it occurs. We do not first see a series of points and then a *figure*. We see a figure at once. As Hartmann points out, we see a certain design as a 'square' before we are aware of the lines of which it is composed. We do not fixate in turn the features which make up a face, but ordinarily respond to the general form of the face before noting its specific details.

A rather striking experiment in 'equivalent stimulation' with human subjects illustrates the way in which we react to patterns of stimuli with a highly organized response. The experiment was designed to reveal the effect of varying the details of stimulation while keeping the general pattern of the situation constant. One group of subjects, for example, learned a pencil maze by practicing each time with a maze identical in both size and pattern. Another group used practice mazes which were alike in pattern but which varied each time in size. The second group of subjects learned as rapidly as those who practiced under unchanging stimulation. They had responded to the scheme of the maze, and since they could not have practiced the same movements at each trial, they must have learned an organized response pattern rather than a chain of highly specific reactions (26).

The complexity of the situation and the response is not an exclusive notion of field theory. Guthrie states that the 'weather signs' for predicting behavior are *stimuli and patterns of stimuli*. He defines association by saying, "A *stimulus pattern* that is acting at the time of a response will, if it recurs, tend to produce that response." And with respect to transfer of appropriate behavior, he points out that "the *general situation* must remain substantially the same." Hull emphasizes that the stimulus is likely in all cases to be "an *exceedingly complex compound* of physical energy events." He also gives implicit recognition of the interaction of specific events when he explains that they do not act additively when combined in a complex situation. He makes it emphatic that "the reaction which will adapt an organism to a given environmental situation depends, as a rule, not upon any single element of that situation but upon a certain combination of elements." Hull also finds that a reaction may be conditioned not only to a single element of a stimulus compound, but to the combination of stimuli. In fact, it is possible to condition responses in such fashion that the situation as a whole will evoke the reaction while separate parts of it will fail to do so. A recent summary

of the evidence on conditioning emphasizes the effect of one response upon another: "It is now clear on both theoretical and experimental grounds that simple chaining of conditioned responses will not predict the characteristics of complex habits. The component responses are greatly altered by virtue of their combination with other responses" (16, p. 20). And again: "The acts measured in determining the form of the goal gradient are not discrete conditioned responses, but are parts of a larger behavior pattern in which separate acts are submerged" (p. 173). The Gestalt psychologist could not ask for more explicit recognition of the doctrine that the nature of the parts depends upon their relations to each other and to the whole!

Thorndike's conception of the situation and the response as patterned phenomena is clearly delineated by Gates' choice of quotations. Thorndike has approximated the Gestalt notion of figure and ground with his principle of identifiability (the character of objects or relationships which makes them distinguishable from other events and from their background or context, the condition which makes the essential aspects of a total situation discriminable). The notions of proportion and emphasis are inherent in his view that the situation and the response are typically unified.

These clean-cut statements of the interdependence of the features or aspects of total situations and responses make it evident that contemporary schools of psychology agree that the behavorial environment is structured and that the organisim's responses are characteristically complex and patterned. The Gestalt movement has renewed the emphasis on the fact of sensory organization, but did not discover it. Woodworth states, "The fact that wholes or complexes present characteristics which are not readily explained by the parts into which the whole can be analyzed has long been obvious to psychologists" (43, p. 621). It remained for the Gestalt psychologists to exploit the systematic or theoretical implications of the principle.

2. Descriptions and Interpretations of Learning, As of All Aspects of Behavior, Must Be Made in Terms of the Mutual Relationships Among Events Rather Than in Terms of Independent Properties or Actions of the Parts

This principle means that if we are to describe adequately what an individual does, we must do so with respect to what he is in relation to the concrete situation in which he acts (27). This generalization is a

logical extension of the concept of organization and complexity in situations and responses. And the essential idea of the mutual interaction of the discriminable features of the organismal-environmental field is either implicit or explicit in all of the theories of learning we are considering.

Guthrie discusses the interference of one set of tendencies or movements with another, and points out that this interference may go deep enough for one movement to inhibit another. He comments upon the familiar fact that for certain movements to occur, one set of muscles must dominate while opposed muscular action is suppressed. The notion of interaction of tendencies seems to be implicit in these accounts of activity. In another place, he explains that new behavior results from new combinations of stimuli which produce *compromise* responses which are also new.

Hull makes the matter of interaction more explicit. He has explained the fact that gray paper on a blue ground will appear to have a yellow tinge (Hartmann uses the same kind of phenomenon to illustrate the action of field forces) by the hypothesis that neural impulses occurring together in the central nervous system *interact and modify each other*. He also states that alien or irrelevant stimuli in a conditioned stimulus pattern will reduce the strength of the reaction tendency, sometimes to the point where the response will not occur at all. Thus emotional upsets, he points out, may be expected to interfere with the child's ability to recite or write an examination.

Hull has repudiated the doctrine of psychological atomism by insisting that he has never assumed that "the more complex forms of behavior are synthesized from reflexes which play the role of building blocks." Hilgard and Marquis (16) have assembled evidence to the effect that it is possible to condition an organism to make different responses to a stimulus pattern and to its component parts. "The important thing is that one pattern of stimuli may be differentiated from another, and the parts do not serve in the whole as they serve alone" (p. 199).

One might not expect to find in conditioning experiments many good illustrations of the dependence of one phase of behavior upon another. Yet a recent writer (42) contended that there is no essential incompatibility between the data from conditioned-response experiments and the principle that the behavior of parts is conditioned by the whole of which they are members. He offered in substantiation of his

conclusion the evidence that quantitative differences in the conditioning of responses are produced by such variables as the following: (1) the attitude of the subject as induced by verbal directions, (2) an active or passive attitude toward the conditioned stimulus, (3) the action of other conditioned responses, (4) organic conditions, and (5) states of activity or quiescence. He also concluded that the human subject's interpretation of the situation led to qualitative differences in the conditioned response.

Sandiford states bluntly that connectionism is atomistic, and that the more complex forms of behavior are additively constructed out of simpler elements. But Gates vigorously disagrees. He not only adduces quotations directly from Thorndike to stress the complexity of the situation and response, but selects statements of Woodworth's to show that selection and combination or analysis and synthesis are not antithetical processes, but complementary functions. Thorndike, Woodworth, and Gates all would agree with Hartmann that seeing differences is as important as seeing likenesses. Learning is in considerable part a process of discriminating one thing from another, not with the intent of destroying their relationships or interdependence, but with the purpose of establishing their *individuality* (14). When we integrate individual responses as a means of attaining some end, we must obviously select the relevant component parts as well as organize them together.

Field theories of learning, of course, give unusual prominence to the organized whole, "big or little, whose properties and structure both explain the localized occurrence that it embraces and simultaneously permit increased control over it." Hartmann has devoted a considerable portion of his paper to an exposition of the characteristics of field action. One of the most important characteristics of a field is that it functions as a unit. The objects or forces within the field do not act independently or successively, but in correlated fashion. They go into action together in a way determined by the interaction of their 'own natures' with the organizing relations of the field as a whole. Thus, in field theory, 'unitary' processes do not mean the action of 'elements' or 'atoms,' or indivisible entities of some sort, but the operation of organized systems as a whole. Lewin believes that such complex and inclusive—or macroscopic—situations as those "covering hours or years can be seen under certain circumstances as a unit."

These situations, to be considered unitary, must possess field properties. Lewin considers such characteristics of social atmosphere as friendliness, autocracy, or democracy to be examples of general field properties of very complex situations. He suggests that complicated psychological structures are somewhat analogous to gravitational or electrical fields in physics. He insists, also, that psychological field properties like social atmosphere can be measured quite accurately.

But we have already seen that the fact of interdependence is not an exclusive possession of field theories. It appears in association theories as well. The idea of functional dependence is implicit in Thorndike's principle of 'belonging.' We may presume that two events belong together when they are members of some larger whole. For example, the relationship of one word to another in the last list of words on page 188 is determined by the meaning of the sentence which constitutes the series. Woodworth has concluded, "Perception of relation precedes association" (43, p. 782). This seems entirely consistent with Köhler's contention that "association depends upon organization" (25, p. 299), and with Lewin's statement that "the cases of association, so far as they refer to changes in knowledge, may well be reinterpreted as relatively simple cases of changes in structure."

The fact of interdependence greatly complicates psychological description and experimentation, for one cannot study a given process in complete isolation, or assume that results under certain conditions will be duplicated under other conditions of motivation, practice, social setting, or experimental procedure. But there is an increasing tendency in psychological investigation to recognize explicitly that the results are relative to the factors which were operating together in the experimental situation.

The educational implications of the interrelatedness of all aspects of human behavior are of profound significance. Dewey has given teachers wise leads in the following passage:

> Perhaps the greatest of all pedagogical fallacies is the notion that a person learns only the particular thing he is studying at the time. Collateral learning in the way of formation of enduring attitudes, of likes and dislikes, may be and often is much more important that the spelling lesson or lesson in geography or history that is learned. For these attitudes are fundamentally what count in the future. The most important thing that can be formed is the desire to go on learning (11, p. 49).

The correlation of several types of learning outcomes is another instance of the effect of one activity upon another. Bode has expressed it in the following way:

> Thinking has to do with the removal of obstacles, and this involves an element of concern or value; else why take the trouble to think at all? The successful culmination of thinking has an attendant esthetic quality, as when we speak in mathematics of a "beautiful demonstration." Thinking, moreover, involves the gathering of data for the testing of hypotheses, which in turn is related both to the acquisition of information and to the development of skills or techniques in observation, in analysis, and in the organization of material. . . . Learning as reconstruction combines thinking, skill, information, and appreciation in a single unitary process, and it is characterized by flexibility, since it must constantly adapt itself to the circumstances of the situation (4, pp. 248-49).

Chapter ix in the second section of this volume treats the relationships of emotion and learning, so that only a brief suggestion of the nature of these relationships need be made here. Successful learning may be expected to breed self-confidence and self-dependence. Progressive mastery of the skills essential for subsequent learning is an excellent basis for future adjustment. Failure may foster timidity and inferiority. Slipshod learning at one stage may become the antecedent of maladjustment at later educational levels. Teachers should constantly consider the influence of one kind of experience upon other phases of development, the effect of what and how the pupil learns at one time upon the results and methods of his learning at a later time.

3. The Organism Must Be Motivated to Learn

Motivating conditions initiate and energize activity, direct the organism's behavior, and dispose it to select some responses and disregard or eliminate others (30). It is interesting to see how different theories of learning interpret these phenomena.

To understand Guthrie's position, one must remember that he states that *motives are stimuli*. All reactions are evoked by stimuli which impinge upon the organism from without or which arise from the action of the body's muscles and glands. Thus many responses are induced by movement-produced stimuli, those which act upon the proprioceptive sense organs imbedded in the muscles themselves. Guthrie also emphasizes the influence of states of readiness related to

internal organic changes and conditions and to muscular tonus. Internal and external stimuli evoke an excitatory condition, which lowers the threshhold for activity. The second general principle of Guthrie's treatment is that these stimuli are usually disturbing or annoying. Interference with activities which are under way is also annoying. The reaction to a persistent disturbing stimulus is variable behavior, which is seldom if ever completely random but instead is related to the organism's previous experience. For example, a child who wants to attract attention when it has been ignored by a group of adults may become very noisy, may do things which are certain to cause reproof by its parents, may walk in the center of the group and go through its favorite stunts, or may break into the situation in some other way. These obviously are not random acts, but are ones which have some possibility of satisfying the child's desire. One of these responses may relieve the motivating condition; in other words, remove the stimulus. Now the important point of Guthrie's system is that the response which removes the stimulus becomes associated with that stimulus.[1] Thus the attention-getting device which works is the one which will probably be used when the child finds itself in the same situation at a later time. In Guthrie's view, the connection between a situation and a response is made, not by any reinforcing effect of the functionally adequate response, but by (1) the fact that the response had been made, even if only once, to the situation, and (2) that since its effect was to remove the stimulus, the association was protected from new learning. In other words, since the stimulus had disappeared, there was no opportunity for some other reaction to occur with it and thus form a new association to displace previous responses. The function of motives in Guthrie's theory is to evoke behavior; the motives are selective in the sense that the motivating condition determines the kind of responses which will remove it. As we shall see later, Guthrie does not believe that goals or purposes give a forward reference to learning behavior.

Hull bases his conception of motivation upon the occurrence of 'organismic needs.' Through the continuous interaction of the organism and its environment, the conditions for survival may depart in greater or lesser degree from the optimum. Originally, of course, the organism's needs are those which depend upon organic or physio-

[1] This hypothesis has been suggested by other psychologists, notably by Hollingworth (18).

logical states. Ultimately, however, through the mediating processes of learning, the organism may experience needs which are only remotely connected with primary physiological conditions. These derived needs, for example, may be stated verbally, and may represent all manner of wants and intentions. In many instances, organic needs may be terminated by automatic physiological adjustments, or by inherited reactions. But in manifold cases, a need cannot be terminated without some change in the relationship of the organism to its environment. When the inherited or previously learned reactions to a need status do not terminate it, the organism responds with varied behavior, which is somewhat better than random. One of these responses may terminate the need. This process occurs whether the need is organic or derived. Tension is released (motive disappears) with the end response. Woodworth has characterized the variable behavior as preparatory responses and the end reaction which terminates the need as consummatory behavior.

So far, Hull's account is much like Guthrie's. Both recognize the presence of needs which are induced by internal and external stimuli, and both point out that the organism's response to a need is variable until some reaction terminates the motivating condition. But there is no assumption in Hull's account that *one* occurrence of a stimulus-response association will suffice to insure that the same response will afterwards be made if the same situation recurs. He considers that the appropriate response will very likely need strengthening through reinforcement, if the probability of its occurrence is to be increased and perhaps raised to near certainty. He conceives a primary reinforcing state of affairs as a reduction in a need. But secondary reinforcing agents, which are situations that have previously been closely associated with reduction in a need or with other situations which were so related, can also operate. Guthrie does not introduce the concept of reinforcement; Hull makes it a fundamental aspect of his system. The former does not incorporate any *law of effect;* the latter goes so far as to make conditioning a special case of the law of effect Both, however, must find a place for motives in evoking adjustive behavior. Hull states, in fact, that an action tendency must be conjoined with the drive[1] sufficiently strong to overcome the resistance

[1] One might ask whether there is really any difference between a drive and an action tendency.

of the reaction mechanism before the response will follow the recurrence of the conditioned stimulus.

Thorndike has always included motivational tendencies in his descriptions of learning. Gates declares that he has given the organism "a uniquely significant role" by exploring the action of mental sets and readinesses, and particularly by making the law of effect the central factor in his psychology of learning. Thorndike has devoted an entire volume to *The Psychology of Wants, Interests, and Attitudes* (37). Much of this book is devoted to experiments on the law of effect, but in a more general discussion of wants in the earlier chapters, Thorndike outlines three broad functions of motives: (1) Inner attitudes or wants often determine behavior much more than the characteristics of the external situation. This certainly gives a dominant status to motivation in his conception of the learning process. (2) Wants may operate to evoke a response which will alter the organism or the situation so that subsequent responses will be more likely to satisfy the need. (3) The immediate effect of motivating conditions is to evoke variable behavior until some response satisfies the want. Perhaps the most important of all the influences of motives, from Thorndike's point of view, is that they are the basis of selection and confirmation. In other words, they determine what responses are satisfying and which ones are annoying. They dispose the organism to repeat or not to repeat certain responses. Motivation, then, is functionally related to reinforcement.

Incidentally, Thorndike, in the volume to which we have just referred, notes especially that wants may coöperate or compete; "they often act together, with summations, alternations, inhibitions, and reinforcements." Perhaps with the deletion of the 'fighting word' *summations*, this observation is closely related to Lewin's description of the behavior of the individual as a resolution of interacting forces or vectors in the total situation in which the organism finds itself. Motivations seldom act alone, or independently. A field of motives nearly always, perhaps always, exists. For example, Lewin has shown in chapter vi that the individual must often choose between two negative valences—two activities both of which are disliked, but not equally repugnant—and that the field may have to be enclosed in some fashion to make the person choose one activity or the other instead of permitting him to escape. He has also explained that the action which a given situation will evoke depends upon the meaning which it has for the organism—

in other words, upon the relationship of that situation to other factors in the total field of the individual at the time. Thus the child will eat some things away from home which he will refuse at his own table; he may use correct language at school or in his home and speak the language of the street on the playground; the adolescent or the adult may indulge in activities he once was taught were wrong if he later finds that the 'best people' are doing them. These are all illustrations of the fact that motivation is a structural phenomenon.

The concepts of tension and goal-directed activity receive large emphasis in the Gestalt treatments of the problem of motivation, although they are not very explicitly developed in Hartmann's chapter. In another place, however, Hartmann (17, p. 199) has stated that "no motive exists without some tension between the organism and its environment." Tension is usually identified with a state of disequilibrium, which disposes the organism to activity until some measure of balance or equilibrium is attained again. This principle, however, is a well-known concept in physiology and more recently in psychology, and is not unique to the Gestalt position. In fact, the idea of tension is entirely compatible with Guthrie's, Hull's, and Gates' expositions of motivation. An organism in a state of need is in a tensional condition.

The nature of the goal is sometimes related to tension. Thus the goal has been defined as "whatever object or situation at the time relieves the most tension, or best balances the tension" (41, p. 273). Lewin has observed that associationism generally has introduced the concept of need and related the notion of the goal to the relief of tension. More often, however, the function of the goal in motivation is more simply expressed. A goal is an end-result; it is a future status more or less clearly apprehended or defined or anticipated at the beginning of a sequence and pattern of learning activities. As learning proceeds, the goal may be more explicitly apprehended, with consequent increase in the directness, precision, and economy of response. Goals not only evoke activity; they are said to determine its direction and organization. Lewin asserts that the associationist's need for some way of accounting for directional tendencies in behavior led him to incorporate the idea of goal-activity into his description of learning. The relation of goal sets to reinforcement and effect will be considered in the following section.

4. Responses During the Learning Process Are Modified by Their Consequences

We have already pointed out that Guthrie does not subscribe to the common belief that responses are strengthened or weakened by their effects. He is convinced that learning takes place on one occasion. In his view, the relief of tension does not reinforce the response which terminates the need; rather, it removes the situation, and thus protects the successful response from being unlearned—in other words, from being supplanted by new associations. Punishment is effective only as it causes the individual to do something else in the same situation which may turn out to be a more adequate response. (Thorndike also considers this action of punishment in evoking other behavior to be one of its possible values.) The statement that a process of learning is modified by its consequences can mean to Guthrie only that an association is protected; the result of the response is to remove the situation.

But to Hull, as we have noted, the reinforcing influence of the consequences of an act is a fundamental feature of learning. He describes the selection and elimination of responses in terms of *differential reinforcements*. There is a tendency for maladaptive responses, i.e., those which do not decrease or possibly actually increase a need, to become gradually weaker through lack of reinforcement. Correlatively, responses which do tend to terminate a need are reinforced with each occurrence, and so are gradually strengthened. Hull has shown that the responses which are closest to the final act which terminates the need will be most strongly reinforced. The more remote a response from the goal-reaction, the less strength it will derive from the effect. Incidentally, this principle of the gradient of reinforcement is strongly suggestive of Thorndike's evidence on the spread of reward. He found that the strengthening influence of a reward spread forward and backward and sideways from the particular response to which the reward was attached.

Thorndike probably has done more research on the influence of the aftereffects or consequences of responses than any other psychologist. From the beginning of his work, he has taken the position that sheer contiguity or frequency is not enough to explain learning. Throughout, he has insisted that the effects of responses are the decisive factors. As Sandiford has said, Thorndike's first statements of the

law of effect were in terms of satisfaction and annoyance, and seemed on the surface at least to stem from the pleasure-pain principle. In other words, the statement was in terms of *affect*. The feeling tone accompanying a response apparently was to be considered as exercising a strengthening or weakening influence. Later Thorndike interpreted the law of effect in more objective terms. He interpreted satisfying affairs as those which the organism strives to attain and preserve, and annoying states as those the organism avoids and abandons. Finally, in recent formulations, he has defined effect as what evokes a confirming reaction.

The law of effect has been widely interpreted in affective terms. Sandiford apparently continued to think of it in essentially hedonic form. This interpretation has stimulated experimental attempts to 'disprove' the law of effect. It has been held, for example, that experiments which have shown that animals and men may learn when the correct responses are punished (31, 32), and in some cases at least, learn as effectively as when the correct responses are rewarded, run counter to the law of effect. Attempts have been made to reconcile the apparent conflict by suggesting that punishments may have an 'emphasizing' influence, or provide certain useful information, or dispose the learner to make a more careful discrimination of cues at critical points. Dashiell, however, has made a more fundamental comment on the learning of responses punished by an electric shock:

> We have let ourselves be surprised at this 'shock-right' phenomenon; but the surprise is due to our having emphasized the word 'shock' and not the word 'right.' But what does 'right' mean? We have been attending to too small a section of fact. We have not considered that this act of choosing one or the other pathway is only a part of a larger behavior-act. The rat was trying to get somewhere, to get something; and if the shocking paths led to that something, there we would have a more basic fact than merely that they were shocked. *Which in this case, I ask, is the effect contemplated by the Law of Effect: is it the shock effect or the right-path-to-objective effect?* (9).

This is substantially like Tolman's query, with respect to the selection of responses, of "what leads to what?" The answer would seem to be that the responses which are selected and learned are those which constitute the right paths to the objective.

The habit of identifying effect with affect lies behind Koffka's criticism of the law of effect in the following passage:

> Historically, 'trial and error' experiments preceded 'insight' experiments, and it is these former which clamor for a law of effect or success. For I am as fully convinced as Thorndike himself that—in these cases—the success of the action performed is responsible for its being learned. I differ from Thorndike only in the interpretation of this effect of success. For Thorndike, success, i.e., the pleasure of attaining the goal, stamps in a previously existing 'connection.' In my theory success transforms a process in such a way as to give it a new 'meaning,' i.e., a new role in its total goal-directed activity (24, p. 252).

But Gates declares that the critics have misread or misinterpreted what Thorndike meant by the law of effect. Gates includes in the meaning of the effect of a response the matter of *whether it furthers or retards progress toward the goal.* "The larger pattern of goals and strivings of the individual determine what results shall be experienced as satisfiers, as fitting and good in that situation, and shall elicit the confirming reaction." This is tantamount to saying that the organism eliminates certain responses because they do not advance or actually impede its progress to the objective, and selects and organizes and learns other responses because they are means to a given end. This is so close to the last sentence in the quotation from Koffka above that the two statements are, for all pragmatic purposes, synonymous.

Where are we, then, with respect to the influence of the consequences or the effects of responses? Responses are associated with a situation if they serve to terminate a need, or 'satisfy' a motive represented in that situation. This may happen biologically, so to speak, without any consciousness or insight on the part of the individual that such a functional relationship or belonging has operated. On the cognitive side, the individual learns those responses which are relevant to his goals and purposes, which he perceives to be means to desired ends. We may conclude with Young (44), then, that from the purposive point of view:

5. "Motivation Is the Direction and Regulation of Behavior Toward a Goal"

Learning behavior is *selective.* It is *directional.* And it is organized with respect to the *attainment of some end or result or condition.* As Woodworth has said, at its highest level of development, motivated

behavior is *objectively purposive.* "A purpose can be defined as a goal-set with foresight of the results to be obtained." In a recent paper on a neglected phase of psychological investigation, Dashiell (7) called attention to the significance of determining tendencies in behavior. "In each case a man is set in a certain way, and what he then does is determined by this set." These determining tendencies are given different names, such as attitude, readiness, mental set, expectancy, or goal-set. The tendencies may vary in the specificity or definiteness of the set or anticipation. But Dashiell has pointed out that they possess certain common characteristics, such as differential readiness (the disposition to react to certain features of the environment rather than others, to make certain responses rather than others, to experience certain activities as relevant and others as irrelevant); persistence or perseveration (either in consciousness or in a subliminal state); and, as they acquire greater specificity, a directing character.

In his discussion of motivation, Guthrie carefully avoids any inference that a goal *as a future condition* is determinative of behavior. The direction of activity is determined, rather, by the nature of the persisting situation. It is only after a certain movement has become associated with this persistent motive (by removing it) that it is possible to say that learning exhibits goal direction. He also insists that we misinterpret the influential factors in learning when we confuse the goal with the act or situation which is effective in removing the persistent motivational condition. Goals thus do not direct behavior; they simply name the situation which removes the activating problem. So Guthrie concludes that instead of talking about goals, which might imply that some future condition "pulls the organism toward it," we should speak of *problems*. This term he believes to be more consistent with the notion of a situation persisting throughout the present, and thus initiating behavior and guiding it in the sense of determining what response of the many which might be evoked will be adequate to remove the motivating condition.

Hull handles the problem of goal-direction through his concept of the "fractional anticipatory goal reaction." He assumes that "a characteristic and dynamic element of the future goal runs like a thread through every moderately well practiced behavior sequence terminating in a major reinforcement." In the case of human learning, this fractional component or feature of the final goal reaction might be a verbal statement of the problem; an imaginal construct, more or less

complete or explicit, of the end to be attained; the presence of some feature or fragment of the total end situation, such as a piece of a melody or a line or two of a poem; the anticipation of a reward or a punishment; or the remembrance of some cue obtained from a model or demonstration of the performance to be made.

This fractional goal situation becomes related to all the movements which lead to the attainment of the goal and thus to reinforcement. It becomes associated with the intermediate goals, or the main steps leading to the final objective. So the continuing partial feature becomes a guiding stimulus leading to the complete goal-response; "a present anticipation of an end does literally lead to the realization of that end." It is in this fashion that Hull 'explains' the nature of intent or purposive behavior.

Thorndike constructed a conceptual framework in his principles of readiness, mental set, and effect for the description of purposive or goal-oriented behavior. One of the most significant chapters in this Yearbook is the one in which Gates, with Thorndike's approval, explicitly states that in the higher forms of learning a 'successful' response is one which is instrumental in attaining a goal or purpose, and an 'unsuccessful' response is one which impedes progress or fails to lead toward the objective. Gates throws into bold relief, in the center of Thorndike's system, what Thorndike himself failed sufficiently to emphasize and what his disciples at times almost entirely disregarded. *Responses are selected, eliminated, organized, and stabilized in terms of their relevance to the learner's goal.*

One reason why most psychologists have hesitated to use the language of goals and purposes is that such terms might seem to imply a teleological theory of behavior. But for descriptive and practical purposes, it is possible to talk about the directing and organizing influence of ends without assuming or accepting any basic philosophical position (10). Woodworth has not been much interested in establishing his own system or 'school,' although his general emphasis is ordinarily called "dynamic psychology." But he has ascribed the economy of learning, in part, to the individual's apprehension of the proper goal in many kinds of activities (43). For example, with respect to the advantage of the whole method of learning, he has concluded that "whatever the size of [the subject's] best learning unit, there are certain important guiding facts which can only be learned by traversing the whole maze. These are the general direction of the goal and the

general course of the right path. Such general orientation may best be acquired early, so as to provide a frame or schema into which the parts can be fitted" (p. 219). One reason for the superiority of recitation in learning over mere rereading is, he believes, that it "furnishes an immediate goal to work for" (p. 210). (He might have said "an immediate *and realistic* goal to work for." The particular traditional goal of 'learning to recite' may not be particularly worth while in modern education, but the principle behind Woodworth's statement is a sound one, nevertheless.) The importance of a clear perception of the goal in acquiring skill and in solving verbal problems will be referred to later.

Whether what is subsumed under goal behavior in the several theories of learning is a persistent problem, an anticipation, a mental set, a purpose, or a goal, the relationship of a determining tendency to economical learning is clear. The most important step in guiding learning is to establish the goal. The fact that the goal concept throughout the discussion has been treated as a dominant aspect of motivation implies that a real goal is one which the individual wants to attain. A goal, in Dewey's words, is a *felt* difficulty. The end-in-view should be made as definite and clear-cut as possible, and should be constantly clarified as the learning process continues. Learning then becomes the process of adapting means to ends. Educational activities which make the acquisition of information a means of accomplishing worth-while purposes capitalize the directive and energizing influence of goals. Experience is most likely to be meaningfully integrated or reorganized when the discovery of new relationships is instrumental to the attainment of the individual's objectives or to the solution of his own problems. Dewey has said that the school has so often failed to stimulate understanding because it has imposed routine tasks instead of presenting problems, and has neglected to set up the conditions for active use of what is being learned. What is learned is meaningful when it is used to bring about consequences (12, pp. 146-47).

6. So-called Trial-and-Error Behavior Might Be More Appropriately Described As a Process of 'Approximation and Correction' or of 'Trying This-and-That Lead to the Goal'

There seems to be complete agreement among the authors of the theoretical chapters that the responses of an organism in a novel

situation are never completely random. The behavior is variable, it is true, but not a matter of chance. Motivating conditions in the organism and perception of the objective situation, even though it is vague, incomplete, or even erroneous, combine to direct and limit in greater or lesser degree the range of trial responses. "Trial and error behavior, then," says Woodworth, "is directed toward a goal but is not controlled by any explicit perception of the relationships involved" (43, p. 747).

Learning has been described as a closer and closer approximation to a successful performance (2). The crux of the learning process is to measure each attempt at performance against a standard, and to adapt the next trial in the light of this evaluation. As insight into the goal, or into the characteristics of the activity as a whole, develops, it is possible to gauge more accurately the appropriateness and inappropriateness of the responses which are tried. Thus modification of behavior is made possible by the discernment of means-end relations.

When the problem is relatively easy, and when the individual attacks it with a favorable set or approaches it from a fortunate angle, the appropriate reorganization of experience may take place suddenly, with practically no trial and error. This immediate perception of the essential relationships has been called insight, and has been dramatized in the Gestalt literature. Some learning curves, however, show a somewhat protracted period of effort with little or no progress, followed by a sudden solution or an adequate performance. There has been a tendency in discussing these cases to emphasize the sudden solution and to disregard the antecedent trials. But the pre-solution behavior may have been exceedingly important. By exploring and manipulating the situation, it may have been possible to discover relationships which were first obscured by the external features of the problem. These activities may also have been instrumental in rearranging the essential factors into new patterns, or bringing them into the same field, so that relationships once difficult to perceive finally became apparent. Such a process of exploration and trial may be either overt or covert. It is probably as valuable to rearrange ideas or approach them from a different angle or set in order to bring them into new and possibly useful relationships as it is to vary one's overt procedure in solving a mechanical puzzle or acquiring a motor skill. The illustrations of problem solving which Hartmann gives in his chapter, and also the formulation and evaluation of tentative hypotheses or attempts at

solution, clearly exhibit this exploratory process. Lewin points out also the advantage of 'standing back' to take a look from a distance at the field as a whole, thereby 'widening the field taken into account.'

We have already pointed out that sudden insight, either immediate or delayed, may not occur, particularly in very difficult problems. The attainment of partial insights and the gradual emergence of understanding of the situation as a whole make the course of learning look very much like that depicted in the typical learning curve.

These interpretations of trial-and-error behavior clearly indicate that preliminary exploration and manipulation and successive efforts at successful performance are not to be set off sharply from solution behavior. Both aspects of learning activity are essential to a comprehensive description of adjustment. Insight may be considered as a *result* which occurs in certain types of learning; it describes the completion, or at least the essential coördination, of the fully organized adequate response. The only sense in which insight may be thought of as a *process* seems to be a methodological one in which the learner makes a systematic effort to discern the essential relationships in the problem. In any event, insight still is a descriptive term, and as such, it may be used to characterize an important phase of learning.

We may agree with Hartmann, then, that:

7. "Learning Is Essentially Complete [Except Perhaps for Attaining Greater Precision or Reaching a Given Level of Performance] When the Individual Has Clearly Perceived the Essential Relationships in the Situation and Has Mastered the Fundamental Principle Involved in the Concrete Problem"

It must be emphasized, however, that this comprehension may not arise through foresight. In the process of trying this or that means of reaching the goal, the successful responses may occur only vaguely or occasionally by design. The crux of the learning process may be principally that of recognizing the appropriateness (or inappropriateness) of the acts after they occur. The evaluation of a response after it has occurred has been called hindsight. But since this evaluation depends upon the discernment of means-end relations, it may be properly subsumed under the general term 'insight.' The fact that the learner 'sees the light' after the response has occurred does not make his behavior less sagacious. Such understanding is a prominent feature of meaningful learning.

8. The Transfer of Learning from One Situation to Another Is Roughly Proportional to the Degree to Which the Situations Are Similar in Structure or Meaning

Every theory of learning must make an effort to account for the transfer of training, for the fact of transfer is clearly evident. Although the systematic interpretations of transfer differ, the dissimilarites are more linguistic than functional.

Experiments in conditioning have shown that transfer frequently occurs in some amount, even in connection with the relatively restricted situations with which these investigations are ordinarily concerned. Thus Hilgard and Marquis conclude, "Every response is elicitable, not just by one stimulus, but by a class of stimuli. Correspondingly, every stimulus elicits, not just one response, but one of a class of responses." Guthrie seems to be more impressed with the specificity of learning than Hull. He asserts, "Behavior learned in the classroom will not be in evidence on the street." He implies that the individual must learn to respond to most of the particular situations he will meet in life, for he says, "It appears that practice is necessary to the extent that the response must be elicitable from a variety of conditions. . . . If we desire the boy to be able to perform in a variety of situations, we must practice in a variety of situations." He describes the learning of a skill, not as the making of an association or a series of connections, but as the acquisition of "many thousands of associations that will connect specific movements with specific situations." Nevertheless, he leaves room for a slight degree of generalization or transfer, for he says that for conditioning to occur the *general situation* must remain substantially the same, and that successful practice must be conducted in the general situation in which the performance subsequently is to be expected. Guthrie knows, however, of no general theoretical principle which would enable him to predict how much a situation might vary from the original one and still evoke the same response.

Hull also recognizes the fact that conditioned stimuli need not recur in exactly their original form to elicit the associated response, but he does point out that as the situations differ more and more from the initial form, the intensity of the reaction progressively decreases. Like Guthrie, he points out that the responses may be conditioned to a large number of points in a given stimulus continuum, so that it will be evoked by many varieties of the basic situation. But Hull also describes how mediating reactions, particularly verbal responses, may

serve to connect a given response with many specific variations of a stimulus pattern.

Hull's conception of the habit-family hierarchy is also closely related to what is conventionally known as transfer or spread of learning. In the process of adjustment, the individual is likely to learn more than one way of reaching the same goal. But all of these alternative response patterns will be conditioned to the same fractional anticipatory goal reaction. Through this mediation, when one response pattern becomes attached to a new situation, all of the equivalent methods of reaching the goal will also become elicitable by the new situation.

Because the critics of the doctrine that transfer of training takes place through "identical elements" in successive situations have fastened the stigma of atomism upon the term, Woodworth has proposed to substitute "identical components" for it. Gates has explained that an identical component, to Thorndike, might mean anything from some fairly specific and striking feature of a total situation to a pattern, or nexus of relationships, in the external field to which the organism responds. Transfer may take place, therefore, either in terms of identical parts or in terms of identical patterns. Apparently Gates would agree with Hartmann, when the latter declares that, "Similarity is similarity of the total pattern and need have nothing to do with any of the parts." At least Gates would insist that there is nothing in Thorndike's conception of identical elements which would exclude the prepotency of patterns or configurations in carrying the burden of transfer. Whether, as Hartmann insists, Thorndike has introduced incongruous concepts into his basic scheme by interjecting the principles of belonging and similarity of pattern, we shall leave for discussion among the theorists. For practical purposes, they seem to be talking about approximately the same things.

Long ago, Thorndike pointed out that we react not only to the gross aspects of situations, but also to their prepotent, and possibly to their subtle, features. Things which are essentially alike may appear on the surface to be very different. When one gets at the bottom of something new, it may not be so novel after all, for he then recognizes similarities which were not obvious at first. But there is no assurance that the learner will dig under the surface of things to their essential characteristics, or their basic structures—their real meanings. As Thorndike has pointed out, transfer depends not only upon the presence of identical components, but upon attitudes and methods which dis-

pose the individual to make an aggressive attempt to discover them. The individual must be guided and trained in systematic methods of getting at the essential features of the situations which life and learning present.

There is no real conflict between the two so-called theories of transfer—identical elements and generalization—for the two ideas are essentially complementary. Generalization occurs by reacting to the feature, principle, or relationship that is common to a number of concrete situations that differ only in nonessential details. Therefore, the process of digging into gross totals to discover their significant characteristics is a means of facilitating generalization, and so the transfer of training.

Finally, there would seem to be no reason why conditioning theory could not accept the hypothesis that generalization and transfer take place by responding to the recurrent pattern in a succession of situations which vary in detail rather than basic structure. Such an interpretation seems consistent with the evidence that responses can be conditioned to a definite arrangement or organization of events, and that the organism can discriminate one pattern as a whole from another. Hilgard and Marquis, for example, report that experiments have shown that a response conditioned to a musical fifth generalized more effectively to other pairs of tones in the same ratio than in other relationships.

In summary, the observation that the transfer from one situation to another is, in general, roughly proportional to the degree of resemblance between them can mean that the similarity can be, and perhaps most often is, that of pattern rather than of specific parts. Further evidence on the relationship between organization of experience and transfer can be found in certain recent experiments on retroactive inhibition. Those investigations have indicated that interaction between original and subsequent learning activities is not so much a function of the detailed constituents of the successive learning materials as it is of their organization (34, 35, 40).

9. Discrimination, As Well As Generalization, Is an Essential Aspect of Effective Learning

Successful adaptive behavior depends upon the ability of the organism to detect differences as well as likenesses. Sometimes human beings overgeneralize, that is, they respond alike to situations which

should not be subsumed under the same class of events; they make a concept or principle much more inclusive than it should be. Actually, generalization and discrimination are correlative processes. Making meanings more exact, for example, is both a process of expansion and restriction. In other words, not only does it involve the extension of a language symbol to wider ranges of experience, but also it often necessitates the exclusion of certain data which were once less discriminatingly subsumed.

The process of reorganizing experience in meaningful and purposeful ways depends upon the ability to note specific details or particular objects in a more inclusive framework. Lewin interprets differentiation as the process of structuring the field. The examples he gives are excellent instances of progressive explication of detail within a structural framework—learning the detailed layout of a geographical area, so that places and streets or roads are clearly located with respect to one another; understanding the social relationships of the environment; developing the self-others discrimination and acquiring a vivid sense of individuality as well as social membership; distinguishing the real from the unreal, and so on.

If one is to gain effective control over experience, he must get beyond the point of dealing only with its gross features. We have already pointed out that one cannot determine whether situations are really similar or dissimilar without reacting to their subtle characteristics. The child learning to read may be able to distinguish certain words from others on the basis of difference in general outline. But other words cannot be so distinguished, for, though different, they may appear to have the same general pattern. Therefore, the child ultimately has to attend to the detailed characteristics of words to discriminate one from the other. Of course, in recognizing words, the child must not only note letters and groups of letters, but must respond to these details in proper relation. This sort of illustration suggests that *differentiation*, which is the process of distinguishing details in a situation first experienced in a more general and unanalyzed form, does not consist in breaking a whole into *isolated* parts. The members of a configuration can attain a real degree of individuality without losing their interdependence. This is what Hartmann means when he talks about the development of an articulated whole. The same concept appears in Lewin's discussion of functional analysis. He objects to the assumption on the part of some critics that field theory is opposed

to analysis or attention to parts. It is upon a certain method of analysis that the field theorist insists. It is essential, says Lewin, to start with the whole, and instead of fastening upon some isolated element, to give progressive attention to the details with full awareness of their relations.

Nevertheless, the process of differentiation can and should often extend far enough for particular objects, events, or 'parts' to attain status in their own right, so to speak. To develop new meanings, or to integrate appropriate phases of previous experience into new and useful patterns, it is necessary to take many things out of their original contexts and to organize them in new relationships. This process of reorganization, then, depends upon the degree to which the individual has distinguished the crucial features of the situations which he has met, and has learned to respond selectively to these more specific and concrete properties.

The concept of differentiation is, of course, not a peculiar phase of field theory. The fact of progressive differentiation and specialization of structure and function has been known and studied for a long time in biology and physiology. Studies in infant behavior have also demonstrated its occurrence (3). We may accept it, then, as a fundamental aspect of behavior.

III. Summary

Learning is an exceedingly complex process. One reaches that conclusion after studying any one of the principal theories of learning. The conclusion becomes still more inescapable when one analyzes several systematic points of view and attempts to reconcile these supposedly distinct positions. But one would arrive at the same judgment by an intensive and critical survey of experiments in learning. For that matter, purely empirical observation of how children or adults learn is sufficient to reveal that the nature of learning is anything but a simple problem. How children learn their spelling words, for example, is a baffling matter that is far from completely understood, and therefore only partially under control in the classroom.

There are many factors, operating interdependently, which determine the process and the product of learning. It is necessary to conjure with the organism, particularly its motives and the nature of its previous experiences; the situation, task, or problem which the organism faces; the conditions under which practice is conducted; the

methods of work which the learner uses; the extrinsic incentives which are applied, such as reward and punishment, and how the subject interprets the incentives; the repertoire of possible responses to the situation which the learner has available to try; the sagacity with which the individual determines the consequences of his acts; and the ingenuity with which he adapts his responses in the light of their relevance to his goal. This is only a partial list of the many variables which are influential in learning. Furthermore, every one of these factors is in itself a complicated dimension. For example, Lewin's discussion of the effect of field forces and the level of aspiration shows how complex the problem of motivation really is.

No one of the essential phases of learning for a given subject at a given time can be altered without inducing some change in the other factors which are operating. This means that we should devise methods of investigating the interrelationships of the major variables or conditions which operate together to produce significant changes in behavior. Although laboratory experiments in learning very frequently serve to identify crucial factors in the learning process, educational psychologists must undertake a systematic attack upon problems of learning which are educationally significant at all levels of maturity. These investigations should have a double orientation. They should be concerned with problems of practical importance in the educational enterprise, and they should also be designed to yield crucial evidence on fundamental questions of the nature and economy of learning. The fact that manifold variables in many interrelationships and in connection with many types of concrete problems should be investigated does not mean that we should not attempt to systematize the results. Rather, we should, as Carr (5) proposes, correct the overly simplified descriptions of learning, and "give a truer insight and appreciation of their essential complexity—to introduce complexity into that which seems to be exceedingly simple, but to describe this complexity in terms of general principles."

Without stopping to debate with Hartmann the justification for eclecticism from the point of view of systematic theory, we may emphasize again the necessity of developing a set of principles numerous enough to embrace all kinds of situations and tasks. We should not try to reduce complex performances, such as problem solving or the acquisition of complicated skills, to the pattern of conditioning. We agree with Hilgard and Marquis that, in our present

state of knowledge, it would be undesirable to extend conditioning principles to learning situations extremely remote from those from which these principles were derived. On the other hand, we see no reason at present unparsimoniously to ascribe the qualities of insightful learning to the many responses which we attach to situations for no other apparent reason than that those situations occurred simultaneously with certain others. So far as any inherent connection between the word and the object is concerned, for example, the child might as well learn to call his pet anything else as well as 'dog.' Many of our attitudes are entirely irrational. We dislike mathematics because we disliked the teacher who taught it. Most of our social attitudes probably have a base equally restricted to the relatively chance occurrence of one situation or condition with another. We apparently do not need the notion of insight to describe learning adequately in these situations. What we need is a body of principles full enough to extend over a very wide range of learning activities. We agree with Lewin that we do not yet possess in psychology—though we may ultimately arrive at that stage—a very few general formulae capable of accounting for the tremendous variety of learning activities.

Although the several theories of learning outlined in this section differ in ways and for reasons which we have discussed, they nevertheless possess in common the series of nine basic attributes which were outlined in this chapter. Still other points of agreement could have been discussed, as, for example, the principle that practice under proper conditions, rather than mere repetition, is conducive to learning. However, we have identified a sufficient number of broad propositions which are consonant from one theory to another to indicate that underneath the distinctions among the systems there are certain fundamental congruities which lay a positive basis for the guidance of learning. These basic principles, when supplemented by the results of research on problems of interest and motivation, practice, the development of meanings, problem solving, transfer of training, and other important phases of learning, have important implications for the educative process. The second section of this volume undertakes to present these constructive approaches to the conditions of effective learning. Not all topics which might have been treated are discussed, but the ones which have been selected are of wide significance in contemporary education.

The chapter on interest and motivation discusses the way in which interests and motives stimulate, direct, and sustain learning. It shows,

too, that there are very few natural interests, but that the great variety of activities which claim man's attention do so because he has become interested in them through learning. It explains, as well, that learning accounts in Allport's words, "for the endless variety of goals sought for by an endless variety of mortals."

The chapter on the relation of emotion to learning presents the interesting conclusion that emotional behavior and learning are related aspects of the broad process of adjustment to the environment. Maladjustment is said to occur when the individual fails to progress from the diffuse and poorly integrated stages of behavior (in which the emotional factor is pronounced) to the more specific, precise, and highly organized behavior which characterizes an effective attack upon problems and obstacles. The discussion explains the importance of purposes and goals and the significance of the level of aspiration in the organization of adjustive behavior. It emphasizes the importance of success and the negative effects of failure and frustration. It emphasizes the fact that the school must recognize that learning is but one part of a much larger and more significant adjustment process for which education is responsible.

"Practice makes perfect" and "learning is not accomplished by practice" are two half-truths for which the chapter on the role of practice in learning substitutes a practical outline of the conditions which make practice productive. Although it is clear that sheer repetition in and of itself may not only be unproductive but actually harmful in learning and that drill for repetition's sake is reprehensible, this discussion shows that there is still a necessary time dimension in learning and that many of man's most complex performances are actually the result of an enormous amount of practice conducted under favorable conditions.

The most important problem in education, and at the same time perhaps the most difficult one in psychology, is the development of meanings. In writing the chapter on language and meaning, Horn found that theory and research in psychology have contributed relatively little directly to the educational problem, but that most of the experimental evidence has come from educational research, which has extensively investigated the attainment of language abilities and language as a medium of instruction. He discusses the nature of ideas, the nature and limitations of language, limitations in the development of meanings or constructs which are inherent in the student, and the in-

fluence of these factors upon understanding. This chapter is replete with illustrations of learning in school situations, and it is full of extremely important implications and applications for teaching and learning.

Although the evidence on reasoning and problem solving, either in the field of general psychology or that of educational psychology, is still meager, the improvement of thinking is one of the most important functions of education in a democratic society. The chapter in section two devoted to this topic provides a survey of the evidence which is available, and is bold enough to suggest tentative principles for the improvement of problem solving in the classroom.

The final chapter is devoted to the psychological foundations of the curriculum, with particular reference to the problems of organization and sequence. At first thought, a chapter on the curriculum may seem out of place in a book on the psychology of learning. But, as the author points out, the curriculum is one of the principal means which the school uses to guide pupils' learning. Although the selection of the content and the experiences of the curriculum is an enterprise in which the psychologist may coöperate with other educational specialists, the form in which the content is organized and graded for efficient learning is the psychologist's particular problem. The literature on the curriculum contains not a few uncritical references to the psychology of learning. The 'subject' curriculum is sometimes condemned by tracing it to the iniquities of 'atomistic' theories of learning. The 'experience' curriculum, on the other hand, has been called the educational counterpart of the 'new psychology.' The reader will be interested to see how these contentions fare in the chapter on the curriculum, and to discover what implications the author finds in an eclectic psychology of learning for curriculum organization and sequence.

The Yearbook Committee hopes that thoughtful consideration of the theory and the research in human learning as discussed in this volume will stimulate the scientific investigation of problems which are of crucial significance in education and which are also important aspects of a systematic formulation of the learning process. A knowledge of the fundamental problems in learning theory and a familiarity with the results of educational and psychological experimentation should enable us to conduct research which will really come to grips with major problems of learning and instruction.

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SECTION II

IMPLICATIONS FOR EDUCATION

CHAPTER VIII

MOTIVATION IN LEARNING

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I. Introduction

A major portion of this volume is devoted to the discussion of learning phenomena as they are described and explained by three influential 'schools' of psychological theory—conditioning, connectionism and field theory. The implications of the problem of motivation for the different viewpoints have been called to the reader's attention in chapters dealing with the several systems, and particularly in chapter vii. Therefore, in the treatment of *motivation in learning* which follows, little specific mention will be made of 'theories of learning.' *Motivation will be considered simply as one of the conditions upon which learning is dependent.* Obviously, it is *only one* of the conditions necessary for learning to occur. A more complete list might take its point of departure from an outline such as the following:

A. *Qualitative Conditions* (which must be met for *any* learning to occur; 'all or none' conditions)

1. The organism must be capable of *multiple response* in a given situation.
2. The organism must be capable of *variability* of response pattern or behavior.
3. The organism must be *plastic;* capable of profiting by or through experience.
4. The *response pattern* to be learned must be one *structurally and functionally possible* for the organism.
5. There must be *energy changes in the environment,* internal and/or external, and the intensity of the changes must exceed the threshold of the behavior to be learned.
6. There must be a *first occurrence of the response pattern* as the result of:

a. chance (pure trial and error)
b. the response being native, or, one previously learned to some element of the situation
c. reasoning; problem solving
d. guidance; tuition
e. imitation

B. *Quantitative Conditions* (which may vary in degree, such variation being directly related to the rate and permanence of learning).

1. Condition of the organism as the result of age, 'capacity,' fatigue, etc.
2. Motivation
   a. Preparatory set (drive; other behavior occurring at the time; amount and kind of related experience; etc.)
   b. Incentive (appropriate to the set), the attainment of which results in reinforcement.
3. Repetition

It should be noted that all of the so-named *qualitative conditions* must be met for learning to occur. On the other hand, the *quantitative conditions* are interdependent and the measurable results of learning are, to a large extent, functions of their interaction. Learning in the classroom may take place with a minimum of motivation provided there is extended practice, or it may occur (more efficiently from the standpoint of most criteria) with a minimum of repetition provided the motivation is strong and appropriate. It is within this frame of reference that the present discussion is presented.

II. The General Problem of Motivation of Behavior

1. Motivation and the Causation of Behavior

Human behavior is always complex. Often the causal[1] factors are not readily discernible. And when they do lend themselves to obser-

[1] 'Cause' is here used to refer to any or all conditions (simple or complex; within or outside the organism) responsible for behavior. Environmental stimuli may serve as 'causes'; relationships between stimuli, or between the organism and its environment also may be 'causes.' The cause of behavior may precede that behavior or it may appear to occur simultaneously with the behavior. Furthermore, there may be interaction of the 'cause' and the behavior it evokes, as a result of which the original 'cause' itself may be altered.

vation they are likely to be so intricately interrelated as to confound the most painstaking attempts at prediction. But all behavior is dependent upon causation. Patterns of response are not emitted spontaneously and independently of causal antecedents. They are directly related to the status of the organism at any given time and to the changes taking place in the external environment. The effects of immediate stimuli have been most prominently discussed in psychology. It has long been recognized, however, that the behavior of an individual at a given time cannot be foretold simply from a knowledge of the stimuli impinging on his nervous system, regardless of how completely the external environment is understood. Something must also be known of the organism's internal state of affairs. The individual's needs, his interests, his attitudes, and their relation to the situation must be taken into account. These are commonly grouped under the more general heading of 'motivation.'

Motivation has to do with the *why* of behavior. It relates to the more remote causal factors. *Conditions within the organism which produce increased activity and which give direction to behavior are motivating conditions.* The motivated animal is active; the satiated animal is quiet. Hunger, thirst, sex excitement have their bases in fundamental tissue needs. Typically they stir the organism to activity and, depending upon which ones are operating, determine the nature and degree of response to a particular incentive situation. Attitudes, interests, and purposes serve similarly to arouse activity and to set the course of that activity.

Bird, in his *Social Psychology* (4), includes the following appropriate comments on the meaning and use of the term *motivation* in describing behavior.

> Motivation is the general term used to designate the dynamic relationships of an organism with its environment. The term does not point to a specific activity or even to a pattern of behavior; stated differently, it does not denote that which has been observed. Motivation is a concept. It is an inference . . . imputed because living organisms do not always respond to similar situations in the same manner. . . .
>
> If similar situations are responded to differently, and if the differences are not explicable in terms of latent habits, elicited as a complex situation is perceived now one way and now another, it is assumed that the effective variable is a changed state of the organism. Knowing that an animal has been fed or kept without food for a

> measured period of time, has been deprived of water or of a mate, we then proceed to postulate a relationship between the state of hunger, thirst, or sexual excitement and the variability of response. Or, having knowledge of antecedent promises, interrupted activities, and planning, each describable as particular expressions of behavior occurring in social situations, we then conclude that a man reacts positively to succeeding situations and neglects others because he intends, desires, or wishes to achieve an objective. Always the state of disequilibrium, tension, or desire, that is of motivation, is imputed or inferred. Motivation is not observable behavior but a concept devised to cover a number of relationships having their immediate point of origin within the organism (4, p. 32).

Several years ago Thorndike undertook to describe certain aspects of motivation in his book, *The Psychology of Wants, Interests and Attitudes* (68). In pointing out the significance of the problem and orienting the reader with respect to the more detailed discussion of special studies which follow, Thorndike listed eight general characteristics of motives as they operate in directing behavior. It is pertinent to note these distinctive features of functioning motives:

> First, a want or interest may be extremely sensitive. For example, whether an animal will eat a bit of given food in a given place depends not only on how hungry it is but also upon whether some other animal is taking bits of it. . . .
>
> Second, there may be action of parts or features or distortions of wants, interests and attitudes. There may be predominance now of one and now of another feature. . . .
>
> Third, they often act together, with summations, alternations, inhibitions, and reinforcements. Curiosity and fear is a classic illustration. . . .
>
> Fourth, the responses evoked by a want at first or early occurrences of a situation are often 'imperfect,' that is, much less well fitted to satisfy the animal than they could be or than they often become after many occurrences. . . .
>
> Fifth, the responses evoked are often multiple and varied. The same situation, according to changes in the animal (the change may be due to nothing more than the continuance of the want and the occurrences of the responses so far made with their results on the animal), evokes one after another of whatever responses are in the animal's repertory in connection with the want, the situation, and the aforesaid changes. . . .

Sixth, the existence of an active want in a creature need not involve any consciousness of what it wants—any ideas or expectations that such and such will satisfy it. At their first occurrences all instinctive wants are typically barren of ideas, and in the lower animals many of them remain so. . . .

Seventh, there are obvious differences in the strength or intensity of wants, but our measurements of these are as yet extremely crude. One want may be stated as stronger or more intense than another by observations of how they feel or by observations of how they make the person behave. . . .

Eighth, the individual differences within the human species in the strength of various wants are very great (68, pp. 12-15).

2. Some Terms Employed in Describing Phenomena of Motivation

The terminology of motivation is, to a large extent, peculiar to the field. Certain key concepts are briefly presented below. Others will be introduced as the discussion proceeds and as the occasion demands.

a. Set. This is perhaps the most fundamental term used in connection with motivation. Probably very few response patterns, overt or symbolic, occur without some preparation on the part of the organism. The preparatory adjustments may be either intentional or involuntary. And the individual may or may not be aware of them. In any event, behavior is influenced to an appreciable degree by what Woodworth has called the "activity in progress." Hunger, fatigue, fear, interests, attitudes, purposes, and similar motives prepare the individual for certain types of behavior. They function as *preparatory sets.* The *set* gives direction to behavior; it provides adjustments favorable to a pattern of activity and thus maintains the course of the activity.

Dashiell, in a discussion of what he refers to as "a neglected dimension to psychological research," calls attention to the importance of *set* in the determination of behavior. What, he asks, is the nature of set? What are the features common to the phenomena variously described by such words as readiness, expectancy, determining tendency, predisposition, set, and the like? There are, he believes, two characteristics that stand out. "We note in all cases an implication of a *differential readiness* . . . [and] . . . we see that each condition has resulted from some form of *perseveration*" (12, p. 301).

Thus, for Dashiell, the essential features of 'set' are *readiness* and *perseveration* of response. The directing character of motives is

ascribable to increased readiness. The purposive or goal-seeking characteristics of some forms of set are manifestations of the perseverative process.

Paschal's recent review of the trend in theories of attention (55) also covers various systematic explanations of aspects of the problem of set or preparatory behavior. Regardless of what its ultimate nature may be, the 'set' of the individual is a potent determiner of response and must be reckoned with in any learning situation.

b. Incentive. Incentives are objects or symbols that the organism strives to attain. The behavior of a motivated organism is to a large extent directed toward incentives of a particular class. When the appropriate incentive is attained or avoided, a motive or drive is temporarily satisfied, and as satiation is approached the activity of the individual diminishes. Incentives are usually thought of as being external to the organism (the drive or motive is internal) in the sense that the incentive situation is provided by something or someone other than the experiencing individual. Thus, a task which challenges the individual's 'mastery motive,' praise to be expected for work well done, relief following avoidance of a situation which is feared, or food which satisfies the hunger drive are all examples of incentives. Motives or drives are sometimes classified as either approaching or avoiding; similarly, incentives may be designated as positive or negative depending upon whether they attract or repel. Whether an incentive is positive or negative depends not on the incentive as such, and alone, but also upon the motive which is functioning at the time.[1]

Incentive and goal are similar in meaning in that both involve situations that the individual has learned to associate with the relief or satisfaction of some motive.

c. Drive; Motive. For practical purposes motives (in the narrower and more correct sense of the word) and drives may be considered two terms referring to the same sort of phenomena. They contribute to the preparatory set of the individual. Drive is more frequently used with

[1] Lewin (40; 41) speaks of the *valences* of incentives—the attracting or repelling power of an incentive dependent upon the meaning of the incentive for the individual. Behavior is observed to be 'approaching' or 'avoiding,' depending upon the positive and negative *psychological* valences of objects in the organism's environment. The valence of a particular object, or incentive, changes in accordance with the needs of the individual. The valances of incentives give direction to behavior.

respect to the physiological needs such as hunger and thirst. But interests, attitudes, purposes, and similar learned determinants of behavior are driving forces in just as real a sense.

Woodworth describes a motive simply, and clearly, as, "a state or set of the individual which disposes him for certain behavior and for seeking certain goals. . . . A motive, or drive, releases some of the organism's store of energy and directs it into a certain channel" (75, pp. 368-69).

In a discussion of learning McGeoch defines a motive as "any condition of the organism which points it toward the practice of a given task and which defines the satisfactory completion of that task" (43, p. 312).

Motives or drives may lead to either approaching or avoiding behavior with respect to an incentive. Holt (28) proposes this sort of a classification of drives, calling them *adient* and *abient*. Adience refers to "the tendency to get more of a stimulus;" abience refers to "the tendency to get less of an exciting stimulus." Similar classifications have divided drives into appetites and aversions (69). Other writers (48), however, have expressed the opinion that both approaching and avoiding behavior are fundamentally similar and that motivation is uni-directional despite outward appearances. Nevertheless, from the observational standpoint, it seems that motives in many instances direct behavior either toward or away from incentive situations.

Drives are sometimes classified as 'internal' or 'external' accordingly as they are aroused by situations within or outside of the organism. Hunger would be an example of an originally internal drive; exploration might be an example of an external drive. Through learning, an originally internal drive may be 'externalized' (2; 59) so the incentive or an external cue serves to arouse the drive behavior; originally external drives, also, may come to be aroused by stimuli within the organism. (See section v, "The Development of Motives.")

d. Purposes; Goals. These terms are commonly used in educational philosophy. It should be noted that goals are identifiable with the incentive-situation;[1] purposes are contributors to *set*. Goals are *defined*

[1] Hull defines 'goal' somewhat differently as "the reinforcing state of affairs towards the attainment of which a behavior sequence of an organism may be directed by its intent" (29, p. 16). Thus, goal is not the same as incentive, but is the organismic state which follows the attainment of an incentive compatible with a functioning motive or drive.

objectives which the individual seeks to attain. Purposes are sets with respect to particular goals.

Tolman employs the terms goal-object, goal-situation, and 'goal' to refer to internal physiological conditions or external environmental objects which the organism is driven toward or away from. 'Purposes' for Tolman are drives or urges to get to or away from a given type of goal-object (69).

Woodworth writes of purposes and their functioning as follows:

> Though the word 'purpose' is sometimes used so broadly as to cover any activity directed to a definite end—any form of goal seeking—it is better reserved for cases where the individual has some *foresight* of the end. Foresight depends on memory, for the outcome of an act cannot be foreseen except by one who has had experience in performing similar acts and noting their results.
>
> A purpose can be defined as a goal-set with foresight of the results to be obtained. It is an idea of certain desirable or undesirable results motivating activity directed toward obtaining or avoiding those results. You can have an idea of a desirable state of affairs without acting on this idea. When you say, 'I'd like to do this, or to have that,' your wish is not yet a purpose, but if you go on to say, 'I'll do it, I'll get it," you have adopted the wish as a purpose (75, p. 396).

e. Intrinsic and Extrinsic Motivation. Motivation is sometimes described as intrinsic or extrinsic. In the case of the former, what the individual does, or learns, is presumably for the sake of engaging in the activity itself. In extrinsic motivation the incentive or goal is artificially introduced into the situation; the motivation is not an original function of the material to be learned or of the learner's attitude toward it. Intrinsic motivation presumably would be involved in swimming, or learning to swim, solely for the pleasure of the activity; learning to swim to attain a Boy Scout rank or to engage in competition, might be cited as examples of extrinsic motivation.

In intrinsic motivation the drive is desire for the activity in question; the incentive is an immediate goal, participation in the activity. In extrinsic motivation the drive is to attain or to avoid an incentive apart from the activity itself; the incentive may be an immediate or a remote goal, which is extraneous to the activity and which may or may not be related to it. A monetary reward for success in learning is an example of an immediate goal, unrelated and extraneous so far as the

learning activity is concerned. 'Graduation' from high school, to which end a pupil may be encouraged to complete courses distasteful to him, is an example of a more remote goal, also extraneous to the learning activity, but directly related to it.

It is sometimes maintained that intrinsic rather than extrinsic motivation is to be desired in directing learning. Obviously certain drives and incentives are more appropriate than others for use in the school when various personal and social factors are considered, but so far as the efficiency of learning is concerned there is little conclusive evidence regarding the superiority of intrinsic motivation. In fact, it would seem to be very desirable to utilize such goals as those pertaining to an individual's career in facilitating the learning process.

In connection with his studies of intrinsic and extrinsic motivating devices Thorndike writes:

> In certain respects, intrinsic interests do possess greater merits. In so far as the task of education . . . is to develop or strengthen certain interests as more or less permanent features of a person's makeup, the more intrinsic the interest can be, the less dependent upon outside aids and circumstances, the better. . . . But their advantages (*intrinsic interests*) . . . have been exaggerated in the educational theories of the last half-century. If an educated adult for any reason is induced by any force, no matter how external, to want to learn a certain thing, no matter how remote learning it is from his other, deeper, and more 'real' needs, he can learn it, provided of course that it is within his powers (68, 152-53).

f. Primary and Secondary Drives. The so-called basic drives, traceable to the tissue needs of the organism, are frequently referred to as 'primary' drives, while those motives which result from learning are called 'secondary.' The secondary drives presumably are derived from the primary drives. Thus, hunger is a primary drive; the drive to succeed professionally may be thought of as a secondary drive developed from the hunger drive, both being directed toward satisfying the organism's need for nutrition.

Primary and secondary drives might equally well be called *universal* and *individual* drives. The so-called primary drives are operative, in varying degrees, in all individuals. They are generally agreed to be native and their functioning is important for the survival of the organism. Just as the drives are universally distributed, so the effective

incentives are fairly constant from individual to individual, though they may vary in details.

Secondary drives, on the other hand, vary from one individual to another. One child may maintain a central interest in stamp-collecting, another in music, still another in sports. The appropriate incentives for the individual motives also differ in like manner; the effective incentive will differ not only with the motive, but also with the particular incentive which through learning has come to be associated with the motive.

III. The Effects of Motivation on the Learning Process

Many definitions of learning explicitly include the concept of motivation. Others recognize motivation as a factor in learning but maintain that it is possible for learning to occur in certain cases in the absence of known drives. Regardless of the viewpoints represented, few persons deny that motivation can and does have an effect upon much learning. Both in the laboratory and in life situations it is self-evident that the functioning of drives is directly related to the efficiency of learning. How motives affect learning has been a matter of conjecture. The neurological processes involved have not been determined. With respect to behavior of organisms when motivation is introduced into learning situations, a number of observations have been made.

It appears that motivation has (1) a *directing effect* and (2) a *reinforcing effect* upon learning. When we say that motives direct learning, we are referring to the problem of preparatory set. The individual's organic needs, his attitudes, his interests, all contribute to his readiness for particular sorts of behavior and help to select and determine the choice of activity. Other things being equal, that activity which is compatible with a need, attitude, interest, or purpose will be engaged in and related activity will be facilitated. But the direction of behavior is only half of the picture. The attainment of an incentive and its quiescent effect upon the drive serve to reinforce the activity that was engaged in, so that the likelihood of the recurrence of that activity is increased. Motives, then, set the stage for learning by facilitating certain activities, and, on the other hand, activities which lead to the satisfaction of motives tend to recur.

It is appropriate to note here that learning is sometimes described in terms of the establishment of relatively 'simple' responses, without

reference to the significance of the behavior to which they contribute, and sometimes in terms of the acquisition of a whole pattern of behavior which meets the requirements of a prescribed criterion. Saliva flow in response to the ringing of a bell, or taking one path instead of another at a 'choice' point in the maze, are examples of the former. The learning of a maze or of a set of French-English equivalents is an example of learning defined in terms of the successful acquisition of a behavior pattern. Guthrie, in a number of instances, and others have called attention to these characteristically different manners of referring to learning.[1] [See Guthrie (25), Hilgard and Marquis (27), Skinner (61), Mowrer (47).] The terminology employed with respect to reinforcement varies in accordance with the manner of approaching learning. Thus, 'reinforcement' (*used in the traditionally proper sense of the term*) in the establishment of simple responses is a state of affairs which is conducive to the future occurrence of a *similar* response. In learning a skill, however, we speak of a 'reward' (or of the operation of the 'law of effect') which is related to a pattern or sequence of behavior (involving *varying* responses as the 'successful' ones are selected) and which results in a state of affairs favoring behavior leading to the goal. Various attempts have been made to reconcile 'reinforcement' and 'effect.' Hull (29), to this end, introduced such concepts as those of the 'goal gradient' and 'habit-family hierarchy' into his theories. Mowrer (47) seeks to show that the basic mechanism of reinforcement is the same in 'anticipatory' (e.g., conditioning) and 'consummatory' (e.g., escape from a problem box) learning. Guthrie (25), in attempting to explain the law of effect in terms of association, concludes that 'reinforcement' of a response, or movement, is simply a case of nondisturbance of an association built up with respect to that response—therefore, the movement is repeated under similar stimulation. The operation of rewards for achievement is described similarly.

[1] In the laboratory, learning studies are sometimes directed at the phenomena associated with the establishment of movements, secretions, etc., and sometimes at learning behavior only as it relates to criteria which have been set up. In classroom learning (and all practical learning situations), the chief interest is in achievement or the acquisition of response patterns, or outcomes, that enable prediction of level of success. In view of this (and also of the more complex causation involved in classroom learning), a breach has unfortunately developed between the laboratory and the classroom in so far as the psychology of learning is concerned. Obviously such a separation is unnecessary. Laboratory and classroom studies in educational psychology should mutually supplement one another.

The term *reinforcement* is used in this discussion to include *both reinforcement* in the narrower sense *and the operation of rewards* or goals, without reference to specific connotations and explanations.

It has been pointed out that drives may be thought of as leading to either approaching or avoiding behavior and that incentives may similarly be classified as positive or negative. Certainly on the surface it would seem that such drives as hunger and such incentives as food are different from such drives as fear and such incentives as punishment. Mowrer has raised the question whether these two apparently opposite trends may not be basically the same and motivation in learning uni-directional. Mowrer writes:

> It is true that living organisms sometimes go away from external objects and sometimes toward them; but in all cases the organism seems, in the final analysis, to be trying to escape from or lessen the motivational stimulation which has set it in motion (48, p. 85).

For Mowrer, preparatory set (or expectancy), then, is a form of discomfort resulting from tension. Both expectancy of punishment and expectancy of reward are forms of discomfort which is alleviated when the incentive is either attained or avoided. Set, or expectancy, is simply "a state of tension or discomfort involving anticipation of the recurrence of one or more . . . needs" (49, p. 38). Tension reduction provides the reinforcement which affects the recurrence of a response pattern.

> Students of human learning have repeatedly asked what 'drive' is 'satisfied' when, for example, a subject memorizes a series of nonsense syllables. And animal experimenters have asked where the element of 'pleasure' or 'gratification' is in the conditioning of a simple withdrawal response, where the conditioned stimulus, for example, is a tone and the unconditioned stimulus a momentary electric shock that cannot be avoided. . . . Eschewing such vague, unanalyzed concepts as 'need for new experience,' 'wish for superiority,' 'desire for social approval,' and so forth, the present writer believes that the extension of the source and scope of motivation required in this connection can be accomplished by simply adding to the organically specifiable needs, the notion of expectancy, i. e., a state of tension or discomfort involving anticipation of the recurrence of one or more of these needs . . . other things equal, the greater the extent of the drop in expectancy-tension after the occurrence of a stimulus-

response sequence, the greater the 'reinforcing,' or learning-inducing, value of this drop (49, pp. 37, 38).

The ideas behind the concepts of 'reinforcement' and 'tension-reduction' are not, of course, entirely new in the literature of the psychology of learning. Thorndike proposed the so-called 'law of effect' many years ago as an explanation of how learning may be reinforced by its affective consequences. Later, his thinking about the problem led to the concept of 'confirming reaction.' (See chapter iv.) Lewin has written extensively of psychological 'tensions' (resulting from the operation of opposing field forces) which lead to restless behavior and which are relieved only when the conflict of forces is resolved. (It should be noted that the disrupting force which produces tensions or tension systems may be simply a time interval or distance from the goal.) Evidence of the existence of such tension systems has been inferred from numerous experiments dealing with memory for uncompleted tasks, level of aspiration, psychical satiation, etc. It may be that, as has been suggested, reinforcement affects behavior by reducing tension systems (whatever they may be) and thus altering the set.

Summarizing, three major problems of motivation in relation to learning appear to be those of: (1) set, (2) incentive, (3) reinforcement. *Set* refers to the preparatory adjustment, the motive, the drive, which arouses an activity. *Incentive* refers to the object or symbol to which the motive or drive is, or comes to be, related or attached. *Reinforcement* refers to the effect of attainment of an incentive upon a related drive or motive. Reinforcement results in a strengthening not only of the drive-incentive relationship, but also of the activity engaged in by the organism in reaching the incentive and effecting reduction of the drive. Actually, reinforcement or drive-reduction seems then to facilitate learning in two ways, (1) directly and (2) indirectly, by increasing the drive value of the set (with which the learning activity is associated) with respect to the particular incentive situation.

IV. Criteria of Motivation in Learning

Motivation must always be inferred; it is not directly observable. The matter of determining when an organism is motivated or the extent of its motivation, therefore, is not simple. In animal experimentation the methods employed have had to do chiefly with the determination

of the extent to which the organism will exert itself in order to satisfy a drive or to attain an incentive. The greater the pain or punishment that is withstood, the stronger the motivation is presumed to be. The existence of drives has also been judged from the persistence of the activity of an animal, through the use of such instruments as the revolving cage.

Problems of human motivation are even more complicated than those dealing with the behavior of lower animals. This is due to no small extent to the functioning of secondary motives made possible by more highly developed symbolic abilities. Relatively little attention has been given the measurement of motives, as such, in human subjects. However, many of the reports which have appeared have been concerned with motivation as it is involved in learning. The criteria of motivation in learning studies, in general, have been adaptations of those used in animal experimentation.

If human learning is in progress, the operation of motives or drives may be inferred when: (1) other things being equal, the efficiency of learning is increased; (2) the learning activity is characterized by persistence; (3) the individual expresses interest, satisfaction, desire, etc.

Thus, the extent to which an individual will exert himself to attain a goal, as revealed in greater efficiency in learning when certain presumed motivational situations are introduced, may be taken as a criterion of motivation. For example, learning is often more readily accomplished (in terms of fewer errors, less time, increased degree of skill or amount of information) when such incentives as praise or blame are introduced. This increased efficiency in learning therefore may be assumed to be a function of the motivational situation.

Persistence in a learning activity as compared with nonpersistence in another, again, may be taken to indicate stronger motivation in the first as compared with the second situation. If individuals of equal ability attempt learning, he who completes learning or progresses farthest toward completion of learning is presumed to be more highly motivated even though the operating motives may not be readily identifiable.

Finally, the individual's subjective or introspective report of interest in, satisfaction with, or feeling toward a subject matter, skill, or any learning situation may indicate the operation of a motive. However, because of the transitoriness of many such states, this criterion of

motivation is likely to be of little practical significance in dealing with the major problems of learning.

V. The Development of Motives

Our present interest in motivation lies principally in the problem of how motives and incentives operate to increase the efficiency of learning. However, it is important that due recognition be accorded the fact that most motives and incentives operating in our daily lives *are themselves learned.* The process is thus a circular one. Learning is aided by the functioning of drives; once acquired, this same 'learning' may come to function as a drive in later-occurring learning situations. We watch a movie which is favorable toward the Chinese; favorable attitudes regarding the Chinese are developed through the experience (our interest in dramatic action, the prestige value of the presumably authoritatively produced film, and similar factors contributing to our learning in the role of motives); now we approach with new interest, the recently acquired attitudes providing the mental set, our study of Chinese philosophy, history, or current problems.

The problem, both theoretical and practical, of the development of purposes, attitudes, interests, and the like, for classroom application is one which might very profitably be dealt with more extensively. The amount of experimental literature in this field, however, is not large, especially so far as practical educational usage is concerned. Many studies have been made of the present status of interests, attitudes, and certain traits in students, but little attention appears to have been given to research on the development of motives suitable for stimulating classroom learning. Suggestions based upon varying educational philosophies have been forthcoming, and many would appear to be worthy of the recognition with which they have been favored. However, more precise analyses, measurement of progress in the development of motives, and comparative data regarding various means of developing these drives, provide important problems for future research in educational psychology.

The manner in which habits, or learned behavior patterns, acquire their driving power is not well understood. Woodworth (74) called attention to an approach to the problem, attempting to describe how, once an activity is started, the means to an end may come to be an end in itself. Behavior leading to satisfaction of a drive may eventually

come to be independent of the original drive and itself acquire the dynamic properties of a motive.[1]

Allport (1) emphasizes what he calls the *functional autonomy* of drives. Like Woodworth, his concern is with the elaboration of motives. Allport thinks of active adult motives as

> Infinitely varied, and . . . self-sustaining, *contemporary* systems, growing out of antecedent systems, but functionally independent of them. Just as a child gradually repudiates his dependence on his parents, develops a will of his own, becomes self-active and self-determining, and outlives his parents, so it is with motives (1, p. 194).
>
> Workmanship is a good example of functional autonomy. A good workman feels compelled to do cleancut jobs even though his security, or the praise of others, no longer depends upon high standards. . . . What was once an instrumental technique becomes a master motive (1, p. 196).

In answer to the question why some habits and skills do not develop increasingly greater driving force as they approach perfection, Allport goes on to say:

> It seems to be neither the perfected talent nor the automatic habit that has driving power, but the imperfect talent and the habit-in-the-making. The child who is *just learning* to speak, to walk, or to dress, is, in fact, likely to engage in these activities for their own sake, precisely as does the adult who has an *unfinished* task in hand. . . . The active motive subsides when its goal is reached, or, in the case of a motor skill, when it has become at last automatic. . . .
>
> Now, in the case of the permanent interests of personality, the situation is the same. A man whose motive is to acquire learning, or to perfect his craft, can never be satisfied that he has reached the end of his quest, for his problems are never completely solved, his skill is never perfect. Lasting interests are recurrent sources of discontent, and from their incompleteness they derive their forward impetus (1, pp. 204-05).[2]

[1] Such a view is not generally compatible with the positions of 'instinct' psychologies, including psychoanalysis, in which all motivation is relegated to some one drive or a limited number of basic drives and the significance of *individual* motives is minimized.

[2] The similarity of this viewpoint and that of Lewin, who believes that *tension systems* once set up may be resolved only by completion of the activity or attainment of a goal, is apparent.

An experimental approach to one aspect of the development of drives (the externalization of drives) has received some attention in the animal field. Even in comparative psychology, however, this important phase of study is just beginning. To the writer's knowledge, no similar studies (unless those of changes in attitudes may be included) of this very complex and difficult problem have been attempted with human children or adults as subjects. Until the development of motives is better understood it is unlikely that the psychology and educational psychology of motivation will make great strides in the stimulation of learning.

Although little experimental evidence on the development of motives is available in the field of human behavior, it is obviously true that many incentives have gained their status as incentives through learning and that many activities have similarly developed into *functionally autonomous* drives. Future research may point the way to the means by which attitudes, interests, and purposes, both of general desirability and of specific value for stimulating subsequent learning, may be developed in the school.

VI. Relativity of Motivation

That large individual differences exist with respect to interests, purposes, and the like has already been implied. One recent study, among many others, bears this out. Ericksen (16) asked a large group of college students to evaluate ten statements relating to the question "Why do I want to make good grades?" Marked variations in rank order of the statements were observed from group to group as the responses of men, women, bright students, poor students, and other groups were compared. Their purposes apparently differed markedly.

Some of the variation noted in motivation is traceable to the dependence of certain motives upon other psychological and physiological factors. For example, interests appear to depend to a fairly large degree upon the individual's ability to participate successfully in an activity. Again, certain interests and attitudes are very definitely sex-related. Changes in interests and attitudes with age are also commonly observed and important. The more pronounced changes in many responses occur at adolescence, but these may be no more important, though more dramatic, than others which are dependent upon the individual's pyramiding experience in addition to his physiological develop-

ment. Belief in the 'transitoriness of instincts' and the acceptance of an extreme educational philosophy of 'striking while the iron is hot' are probably not tenable today, but interests, attitudes, needs, and purposes do change and it is important for the educator to capitalize them as motivational devices when they may be driving factors in a child's learning efforts.

The practical use of motivational devices requires far more than simply the recognition that sex, age, ability, and grade groups differ in their drives. It must necessarily be remembered that individual motives, or motives in the individual, can be properly understood only in relation to that particular individual's whole background of experience and in light of unique personality factors contributing to his behavior. The experience of one child and the attitudes he has developed, might well cause him to respond effectively to praise under one set of circumstances and to blame under another. Or, the same type of incentive, objectively viewed, a reprimand let us say, may differ in its effect upon the behavior of the class 'grind' and the 'good fellow' of the group. The individual's relationship with his group and his relationship with other environmental factors may be important determiners of his response to intended incentives.

Such concepts as those of 'level of aspiration' and 'psychical satiation,' originating in the writings and experiments of Lewin and his students, serve to illustrate further the individual features of motivation. 'Level of aspiration' refers to intermediate goals which the individual sets up during his activity. Frank defines level of aspiration as "the level of future performance in a familiar task which an individual, knowing his level of past performance in that task, explicitly undertakes to reach" (18). The individual adopts a standard of attainment, based partly upon his past experiences and partly upon what he thinks he may be able to do in the future, and this functions as a motivational device in learning. Success or failure in attaining these intermediate goals, in turn, affects subsequent levels of aspiration.

The effect of drive satiation on the learning of animals is readily and often observed; a well-fed rat makes a poor subject in a learning experiment. Similarly in human learning, drives sometimes temporarily and sometimes permanently apparently cease to produce the desired effects upon learning as a result of their overuse. The popular phrase 'fed up' should not be thought of too lightly. Learning may reasonably be expected to show a slowing up if the motive or a par-

ticular incentive has been employed too regularly. Praise may lose its value if too generously bestowed; similarly, an individual may become inured to punishment or blame.

As a concluding word with regard to the relativity of motives, attention is again directed to the necessity that an incentive be appropriate to the functioning motive. Water is not a satisfactory incentive for a hungry animal; solving arithmetic problems for an hour after school because a lesson was incorrectly done is not likely to stimulate an interest in arithmetic. The teacher's problem is not only to discover what drives or motives may be significant enough in an individual pupil's life to aid the learning process, but also to find the incentive to which the motive is responsive.

Finally, the factors which may be operative in motivating learning are numerous and they are also involved in complex interrelationships. Many motives may function concurrently. Each will probably have a mutually facilitating effect upon many others, and at the same time will be in conflict with many more. Motivation applied to learning involves the advantageous manipulation of incentives and use of drives so as to maximize the facilitating and to minimize the inhibiting effects with respect to specific learnings.

VII. Meaning and Motivation

It is commonly assumed and taken into account in most educational endeavors that meaningful material is more easily learned than that which is meaningless. It is simple to observe the ready learning of a short sentence in one's native language and the relative difficulty the same person experiences in trying to learn nonsense syllables totaling the same number of letters. Numerous illustrations might be provided. The value of the initial reading, rather than recitation from the beginning, in the experiments of Gates and others undoubtedly is due in no small part to the meaningfulness such an overview contributes to the individual's learning. The extent to which an individual has had previous experience with a situation, the degree to which this situation is ordered and logical, and the degree to which its relationships to a goal can be understood—these determine its meaningfulness. The school, through integrated lessons and courses, carefully planned and related to practical and commonly experienced situations, has attempted to make the materials it purports to teach more meaningful.

Learning may occur with a minimum of meaning, but it becomes much more efficient as the meaningfulness is increased.

Meaning may be considered an aspect of the problem of motivation. While it can hardly be referred to as a drive in the usual sense of that term, it obviously contributes to the 'set' for learning. Material which is meaningful to the learner will obtain preference over meaningless material; the organism is predisposed to behavior which involves meaningful situations.

The problem of meaning is very closely allied to that of interest. Although meaning probably is not the basic feature of interest, and although materials may be meaningful without necessarily being interesting, it is improbable that interest can be present without at least a minimum of meaning. True, interest is sometimes stimulated by what one does not know about a thing; one is curious and driven to discover more; but the very existence of interest necessitates some grasp of the relationships involved.

One of the important tasks of the teacher in motivating learning is that concerned with the development of meanings. The meaningfulness of learning materials is dependent upon several factors related to the manner of presentation. The teacher who purports to facilitate learning through attention to the problem of meaning regards them as fundamental to the educative process. They are either explicitly or implicitly taken into account to some degree in every instance of classroom learning.

Meanings may be developed through attention to the following basic conditions:

(1) The meaningfulness of learning materials is dependent upon a broad background of related experience, of facts and principles about the situation, course, or subject-field with respect to which learning is sought.

(2) The meaningfulness of learning materials is dependent upon the awareness of relationships existing between the old and the new, between past experience and present experience. New learning should be related to situations in which the learner already possesses information and interest. This may be accomplished either directly or indirectly.

(3) The meaningfulness of learning materials is dependent upon the organization of the material to be learned. The logical relationships of the situations must be used to advantage.

(4) The meaningfulness of materials to be learned is dependent upon the awareness of relationship between the learning situation and the possible future applications of the learning. The purposefulness of learning is directly related to its meaning.

VIII. Some Types of Motives and Incentives Which Affect Learning

It was pointed out earlier in this discussion that learning is affected both by set and by reinforcement. Obviously these are not distinct problems since motive and incentive are interdependent and must be considered in relation to each other. An incentive must be compatible with a functioning drive in order for reinforcement of the activity leading to the incentive to occur; when, also, the attainment of an incentive leads to the reduction of drive, or the activity is reinforced, this reinforcement results in an extension of the motive-situation to include the activity. By listing separately certain types of motives and certain types of incentives as these factors affect learning, one runs the risk of lending to false impressions of their independence. Nevertheless, since set refers to the behavior of an organism and incentive refers to objects or symbols external to the organism, such a classification will be adopted in the following discussion.

A Partial List of Motives and Incentives Which Affect Learning

Factors Relating to the Release and Direction of Activity	*Factors Relating to the Incentive Situation*
Wants and Needs	Rewards and Punishments
Traits	Material rewards
Attitudes	Praise and blame
Interests	Punishment
Habits and Skills	Group Recognition
Purposes	Knowledge of Progress
Affective and Emotional Conditions	

1. Wants and Needs

Strictly speaking, wants refer to desires, needs to demands. Needs presumably always result in activity leading to satisfaction of the demands. Wants are less forceful; they may lead to activity or they

may be passively accepted by the individual without his doing anything to satisfy them. Both terms, wants and needs, however, can be considered together in that they refer to 'requirements' of the organism. Both are positive or forward-working, since, if the want or need is strong enough, the individual will seek actively to attain the object or end that will satisfy the want or need and reëstablish psychological balance. The human individual is usually aware of his wants or needs, although consciousness of them does not always accompany the drive. Wants and needs include both learned and unlearned elements. The fundamental tissue drives in their original manifestations are unlearned. Many needs, however, are not native and appear to be unrelated to the maintenance of physiological conditions. Instead, they seem to have resulted from an extension of the individual's experience and the subsequent introduction of new demands. In spite of the secondary nature of such needs, they are still potent determiners of activity and as such may play important roles in the motivation of learning. Wise teachers attempt to create wants and needs for certain skills and knowledge by openly or subtly pointing out the relation of the material to be learned to some present interest or purpose, the goal of which is incapable of attainment apart from the acquisition of that skill or knowledge. The efficacy of the project method as a motivational device lies to a large extent in the introduction of 'gaps' in the individual's knowledge, which, to be successfully bridged, require the extension of his information or skill.

Drives dependent upon fundamental tissue needs are undoubtedly the prime movers of life. Their influence over a wide range of the organism's behavior can be readily observed in animals such as the rat or the dog. These animals behave directly in relation to such basic drives as hunger, thirst, rest-hunger, sex-hunger, etc. In man such factors are still basic in determining his behavior. However, 'civilization' and the mores of the group have disguised the drives so that their direct expression and effect on behavior are less obvious. Secondary motives have been developed which often serve the same ends, and the relationship between the primary and secondary source of motivation is sometimes relatively obscure. The satisfaction of hunger in human beings is no longer a matter of going forth and seeking food which may be immediately desired. Instead, one may work for money which may be retained for the purchase of food to serve when the conveniently set mealtimes come around.

The list of basic drives also may be extended beyond those associated with the more obviously related tissue needs. The drive to explore or manipulate, to seek novelty, to enjoy oneself, to assert oneself, to provide security for oneself, to overcome resistance, to seek the recognition of others, for example, may be mentioned. Many of these motives are distinctly social in that they involve the individual in relation to other members of his group.

2. Traits

Traits refer to natural or acquired patterns of response which predispose the individual to more or less common reactions in a wide range of situations. Allport defines a trait more specifically as:

> A generalized and focalized neuropsychic system (peculiar to the individual), with the capacity to render many stimuli functionally equivalent, and to initiate and guide consistent (equivalent) forms of adaptive and expressive behavior (1, p. 295).

Traits are inferred from the manner in which an individual acts or behaves. Sociability, suggestibility, honesty, dominance, and the like are examples of traits which may characterize an individual. An individual's traits serve as determining tendencies or sets and as such may function as important motives in a learning situation. Learning information or learning a new skill is facilitated if it may be related to functioning personality traits of an individual. Learning an activity which is in conflict with one's existing traits is likely to suffer from the standpoint of efficiency.

3. Attitudes

Attitudes are learned patterns of response which predispose the individual to rather specific behavior in given situations. Traits and attitudes are very similar, and the distinction between them is not always clear. Attitudes, however, are always acquired, whereas traits may be either native, in the sense that they are based upon some constitutional factor, or learned. Allport (1) points out in addition that (a) attitudes always have well-defined objects of reference, whereas traits have no such specific reference to objects; (b) attitudes may be specific or general, while traits may be only general; and (c) attitudes are attached to objects or values and are usually of either a favorable or an unfavorable nature, whereas traits usually have no such clearcut direction.

Attitudes are expressed as desires, needs, opinions, sentiments, prejudices, interests, and the like. Our opinions regarding law enforcement, war, the Republican party, or our next-door neighbor; our beliefs in an ideal, a religious system, or scientific fact; and our sentimental feeling for a parent or a loved one, all of these are examples of attitudes. When a particular attitude is active, it functions as a set, so that associated activities are facilitated and unrelated activities are inhibited.[1]

A very important group of attitudes includes those which have as their objects the life values accepted by an individual (62). One's aesthetic, religious, economic, theoretical (or scientific), or political interests are potent factors in determining his set at a given moment. They influence a wide range of behavior and tend to function throughout time intervals of some length.

4. Interests

The place of interests in a classification which includes traits and attitudes is difficult to determine. An interest may be classified either as a trait or as an attitude, depending, largely, on whether it is broad or narrow in its reference. At any rate, interests are *learned* responses which predispose the organism to certain lines of activity and which definitely facilitate *attention*. A trait or an attitude may favor activity of a given sort without involving the clear awareness and concentrated activity involved when we are 'paying attention' to something. Interests definitely facilitate attending activity. Since they not only provide a set or readiness for behavior but also bring the factor of attention prominently into the picture, they are particularly significant as motives in learning. Learning which is related to the interests of the individual may reasonably be expected to be more efficient and to be better retained. Other things being equal: (1) situations with which the individual has had previous experience are likely to be more interesting; (2) activities in which he has been most successful are likely to be interesting; (3) activities which are pleasing are likely to be more interesting; and (4) activities at his level of intelligence or ability are likely to prove of most interest. Learning should proceed whenever possible, perhaps, in relation to existing interests. However, it should

[1] Woodworth (75) speaks of attitudes as providing sets or dispositions, depending upon whether the attitude is active or inactive. When it is active, it functions as a set; when it is inactive, as a disposition, disposing the individual to take an active attitude or set when the reference object is mentioned.

be remembered that *interests are themselves learned* and that learning, using individual interests as its starting-point, must be carefully directed so as to extend well beyond the original interest field. Otherwise, the desirable breadth of experience may be considerably limited.

5. Habits and Skills

Previous learning always sets the stage for subsequent learning. Activity which is similar or related to earlier activity is facilitated. Therefore, habits and skills serve as motives to the extent that new learning which is in line with existing response patterns will be more easily acquired. Furthermore, achievement breeds interest; the interest value of new learning is enhanced by its relationship with earlier learning. Ordinarily, then, our interest will be greater in things with which we have had previous experience.

One important aspect of the problem of habits and skills as motives has to do with 'habits of work or study' and their influence upon learning. There is no question but that certain habits are more conducive to efficient learning than are others. 'Study hints' are sometimes ineffective with college students, not because the 'hints' themselves may not be useful, but because they have not been developed into 'habits.' Their usefulness depends upon their becoming habitual in the individual's approach to learning.

6. Purposes

Purposes may, in a sense, be thought of as needs. When a purpose has been accepted, new requirements are introduced into an individual's behavior. One is aware of his purposes and intentions and consciously strives to attain the goal toward which the purposes are directed. Purposes serve to energize and guide the learning process by increasing the readiness for response. Other things equal, the more completely a purpose is accepted and understood, and the goal recognized, the more efficient will be the learning. Teaching at its best aims toward the development of purposes in the learner by assisting him to attain foresight into the consequences and applications of learning.

7. Affective and Emotional Factors

Feelings and emotional states are obviously important contributors to the preparatory set for an activity. Whether or not an individual *likes* what he is doing (and therefore is aware of the pleasantness that

the experience yields) and whether or not he is experiencing the *excitement* characteristic of emotions, are factors which often have direct bearing on the efficiency of learning. These affective and emotional factors function most prominently in the reinforcement of learning. But they are also important from the standpoint of 'set,' as has been indicated by various studies. For example, Carter, Jones, and Shock (9) have shown that lists made up of words more commonly associated with pleasantness are more easily learned than are lists of words associated with unpleasantness, and both of these are conducive to more rapid learning than are indifferent materials.

The pupil's like or dislike for his teacher or his school (both of which are elements of the learning situation for the learner) must also be considered in this connection. It is not uncommon for dislike for the teacher to carry over to dislike for the material and consequently to conflict with the pupil's learning.

The organism which is emotionally aroused is an alert organism. It is probably for this reason that learning which takes place when the individual is experiencing an emotion is likely to be more efficient. Emotion, it seems, may either facilitate or inhibit learning. Intense emotional experiences are probably conducive to learning which is closely related to the emotional situation. On the other hand, the same emotion may have disruptive effects upon learning of a different character and remote from the immediate situation.

8. Rewards and Punishments

'Rewards and punishments' may be considered one of the major categories under which incentives may be classified. In fact, it is likely that *all* incentives could be thought of, either directly or indirectly, as rewards or punishments. For the present purposes, however, such incentives as 'group recognition' and 'knowledge of progress' will be taken up independently. Under 'rewards and punishments' will be included the three overlapping topics, 'material rewards,' 'praise and blame,' and 'punishment.' Blame is, of course, a form of punishment, and the separation is made here simply because the effects of praise and of reproof have often been studied in relation to one another, and it seems expedient to discuss these incentives together, and apart from the more general topic of punishment.

a. Material Rewards. Various material rewards have been used as incentives in motivating learning. Meier (45) found that candy, and

also toys and money, were effective even with feeble-minded children in improving reading ability. Crawford (10) compared scholarship students, who were released from tuition payment at Yale as a reward for high marks, with nonscholarship students matched for ability and promise and reported marked differences in grades received, favoring the scholarship group. Financial aid seemed to be a strong incentive.[1]

A chocolate bar, used by Leuba (38) as an incentive with an experimental group of fifth-grade children, seemed to contribute to improvement at working multiplication problems. A control group did not show a similar gain.

Thorndike (68) and others similarly have reported increased efficiency in learning, at least to a certain point, with monetary and other material rewards. The amount of the monetary reward has usually been small.

b. Praise and Blame. Rewards may be material or they may be symbolic. Thus, praise, personal attention, group recognition, or even feeling of accomplishment may serve as rewards in quite the same manner as does money or some desirable object. *Praise and blame* are examples of verbal rewards and punishments. A number of studies have been conducted for the purpose of determining the relative effectiveness of praise and blame with respect to the learning situation. It should be noted that various investigators have pointed out that the real value of praise and blame as incentives has been rather generally confused because of the difficulty of isolating these variables for experimental study. Not only praise and blame, but other incentives as well, are likely to creep into the results of even the most carefully controlled experiments on motivation in learning.

Briggs (7), Laird (35, 36), and others have approached the question of the relative effectiveness of praise or blame from the standpoint of the stated opinions of students. According to the replies from question-

[1] It should be noted perhaps that all of the difference in achievement between the 'scholarship' and nonscholarship groups cannot be attributed to the monetary reward alone. The students who applied for and received scholarships were more highly motivated with respect to academic studies at the very beginning of their collegiate study. The fact that they were temporarily frustrated in their desire for a college education by a financial factor, and that they sought means of attaining their end in spite of such a barrier, points to the likelihood that other motivational devices than the monetary reward were involved in their superiority to the matched group of students who apparently had experienced no such interference in their plans for continued study

naires, public reprimand, sarcasm, and ridicule will not often lead to improvement. Private reprimand was believed to be fruitful in a relatively large number of cases, and public praise was found to be the most effective of the incentives about which questions were raised.

Wood (73) in an experimental situation found students in a group that was praised for learning nonsense syllables to show the greatest improvement over earlier performance, a group that was reproved to show almost as much improvement, and a control group to show very little or no improvement over previous performance. Brenner (6) found neither praise nor blame particularly effective as an incentive in a study of third-grade children engaged in learning word-lists. The 'praised' and 'blamed' groups were separated during the investigation.

In an unique experiment Waits (71) rewarded successful responses with a small amount of money, punished wrong responses by electric shock, and, in addition, caused the situation which was responded to incorrectly to be repeated until a successful response was obtained. The results led to the conclusion that reward was effective in learning but that when the reward was preceded by punishment, the effect of the reward was interfered with.

Hurlock (30) practiced matched groups of children at arithmetic and found 'praised,' 'reproved,' and 'ignored' sections to improve in the order named. A control group showed a slight loss. Brenner (6) found blame slightly more effective than praise (and neither very important) under different conditions from those Hurlock employed, and points to the effect of the social situation (the praised, reproved, and ignored group each was aware of the incentive or lack of it that was used with the other groups) as a confusing element in Hurlock's results. Variation in the verbal expression of praise and blame from one experiment to another also is likely to be an important factor.

Schmidt (57) in a recent study in which two different experimenters were used, observed that the *individual administering praise or blame* in a learning situation plays a deciding role in the results obtained. No significant differences were found in this study between the effects of praise or blame as incentives.

The judicious use of praise and/or blame always takes into account the individual learner and his reaction under similar previous circumstances.

c. Punishment. Punishment, physical and symbolic, has been extensively used in educational practices. Reprimand, sarcasm, detention,

and physical contact have been used in an attempt to influence learning. In general, it may be concluded that punishment does alter the learner's behavior as he seeks to avoid it in the future. *Real* punishment apparently leads to the replacement by another response of the response for which punishment was administered. However, recent studies seem to indicate that mild punishment for right responses at times may aid in the establishment rather than in the elimination of a response. Punishment seems in these cases to serve simply as a cue. In this connection it will be recalled that Mowrer (48) maintains motivation is unidirectional and that the basic phenomenon is tension-reduction. According to his viewpoint, even punishment is *sought* by the organism because it relieves the tension system in operation. Thus, punishment may, in this sense, actually be viewed as a reward.

Needless to say, punishment in the school, if it is applied at all, should be related to the behavior for which the pupil is punished. Punishment for punishment's sake has no effect upon learning and may produce decidedly unsatisfactory results in other respects. If it is made clear to the learner what the punishment is for (other things being equal), the effects may be noted in improved learning. The other-things-being-equal factor involves to a large extent the particular learner, his attitude toward the subject matter, his opinion of the teacher, his relation to his classmates, the attitude the class as a whole has developed toward the teacher, etc.

Thorndike suggests the following ways in which the use of punishments may be improved:

> The first is to try to make sure in each case that the punishment belongs to the behavior in question. . . .
>
> The second is to forestall the punishment in cases where the want which led to the offense can be satisfied innocently. . . .
>
> The third is to shift the emphasis from the discomfort of A to the relief, security, and comfort of not-A, when it is prudent to do so, as it usually is.
>
> The fourth is to search for ingenious ways of using the sure and almost fool-proof methods of arousing the confirming reaction by attaching relevant satisfiers to the desired connections, in place of punishments for wrong connections. . . .
>
> The fifth is to arrange in a scientific, or at least a reasonable, manner the punishments which, even after the fullest use of rewards, will still remain as important means of human control (68, pp. 151-52).

9. Group Recognition

The regard accorded an individual by the other members of his group exerts an important influence upon his behavior. Group recognition is undoubtedly one of the most powerful incentives and one which the individual strives to attain in many specific ways and particularly through conformity and competition. The individual's striving to conform may be noted in any number of circumstances. Not only does he actively seek to conform with what the major social group of which he is a member thinks and does (the folkways and mores, the universally observed culture patterns, etc.), but there may also be conformity of attitude and behavior with respect to some small group (the fraternity or club, the social elite, the members of a profession, or one's teachers) in an effort to gain its recognition and approval.

Numerous studies have been conducted in the effort to determine the effect of the presence of other persons, both as observers and as competitors, upon an individual's learning behavior. The presence of other persons as observers apparently does not stimulate learning activity. To the contrary, most investigators have found that a skill is interfered with by such a social situation. Burri (8), for example, found the retention of learned materials to be seriously disturbed by the presence of an audience even when the subjects had been told during the original learning that others would be present during the retention test.

Undoubtedly the effect of observers in a learning situation depends to a large extent upon the regularity of the presence of the audience and the familiarity, therefore, of the learners with that group situation. The learning of the pupils in demonstration classes is not generally thought to be inferior as a result of the presence of observers.

When a number of persons are engaged in the same activity in one another's presence, a much different situation is involved. Here the other individuals serve, with respect to any given individual, as competitors, not observers. The effect of the others upon activity is not simply the effect of a passive group. Competition in our society has been especially important. It is possible that in another social milieu individuals might learn to regard coöperation as highly as individual attainment has been thought of in our own culture. Murphy (51), in her study of sympathy in young children, reports results leading to the conclusion that the child's social environment is a deciding factor in determining such traits as self-centeredness (and competitiveness), on

the one hand, or sympathy (and group-consciousness) on the other. Greenberg's study (24) indicates that competition may develop rather gradually as children grow older. Whether this results from a social environment of competition or from other factors not within our control is a question that cannot be answered. Nevertheless, the results showed that children exhibited competition increasingly as they grew older.

Hurlock (32) reported that the performance of fourth- and fifth-grade children in working arithmetic problems was decidedly improved when rivalry between equated groups was engaged in during practice. A control group showed no such effects. Leuba (38), studying fifth-grade children working at two-digit multiplication problems, found group rivalry to improve performance as much as 47 per cent.

Improvement with practice under two types of competitive situations was studied by Sims (60), who found that a control group improved 102 per cent, a group-motivated section (working for the group to which they belonged) 109 per cent, and an individually-motivated group (working for self) 157 per cent. Competing for oneself would seem to be considerably more effective than competing for a group to which one belongs.

Maller (44) attempted to determine the extent that fifth- to eighth-grade children would exert themselves in competition for individual honors as against competition for the group. In a test situation involving simple additions the children did more work for themselves than for a group. In *practice* at solving the problems the differences favored individual competition still more. When the children could choose whether to work for self or for group, 74 per cent of the time the choice was for self. Individual children who divided their time between work for self and work for group were found to show a much greater output when working for self than when working for a group.

Rivalry or competition does, then, appear to have a facilitating effect on learning.

10. Knowledge of Progress

It is sometimes held that competition against oneself is a more desirable form of rivalry than competition with others. The incentive in such situations presumably will be a standard set for future attainment based upon previous attainments. A number of investigations have been planned in the attempt to ascertain whether or not knowledge of one's

previous learning will aid one (will contribute to the motivation) in subsequent learning.

Knowledge of results or progress may take two forms. In the first place, one may be informed of his progress by being told (in any one of a number of ways) of his improvement from time to time during the learning. Again, a convenient self-check is provided when the individual engages in 'recitation' during his learning. In any event, it is probably impossible to control such an experiment completely because of the difficulty of preventing the individual (1) from gaining at least some knowledge of his progress (during the control trials) and (2) from knowing at least something of the progress that is being made by other persons engaged in the same experiment (thus introducing the factor of competition with others). Although these difficulties have not been completely ruled out, there appears to be good reason to believe that knowledge of results does serve to motivate learning.

One of the earliest studies of this problem, in which any large number of students was employed, was the investigation of Book and Norvell (5). College juniors and seniors were practiced at simple learning tasks, one group being kept ignorant of results although told to work as hard as possible and the other group being told to count their scores and to do better each time. The results were impressively in favor of learning which involved knowledge of progress. Deputy (15), using objective examinations as a means of informing certain students of their results, found that 'informed' groups showed improvement in college work that was not shown by members of a control group. Noll (53), however, in a somewhat similar study reports opposite results. Panlasigui and Knight (54), in an experiment involving selected schools in a large area, found control groups to gain little in a series of drills in arithmetic, whereas groups comprised of individuals informed of their progress made significant gains.

Forlano (17) found that knowledge of results in learning produced more efficient behavior than when such knowledge was withheld and that the effect was most pronounced when the information was delayed one day as compared to knowledge provided immediately after performance. The difference between immediate and delayed knowledge of results, however, was not statistically significant.

Symonds and Chase (65), in an investigation involving over two thousand sixth-grade children and their learning of correct English usage, noted that individuals who were informed of the progress they

made were superior to those who practiced with no particular motivation and to those for whom the motivation was 'application' of the knowledge acquired. The writers concluded that one learning trial involving knowledge of results was equal to five 'unmotivated' repetitions of material.

With respect to recitation in learning, Gates (22) observed that learning was more efficient when the individual learner first read the material through several times and then paid attention chiefly to recitation (attempting to see how much could be recalled without reference to the source). Learning with recitation seemed superior to learning in which the individual had no knowledge of his progress, both for nonsense materials and for meaningful materials. Seibert (58) similarly performed an experiment in a college class, using as materials lists of French-English words. Superiority for learning with recitation was observed, both for immediate recall and when retention was tested, although the effect was not so great as that found by Gates. Forlano (17), employing a normal elementary-school classroom situation, reports recitation to be decidedly superior to mere reading. Recitation also was found to be almost as efficient with sense as with nonsense materials. The superiority of recitation was even more readily observable in delayed-retention tests than in tests of immediate retention.

IX. Motivation in the Classroom

Although this discussion in its entirety has centered in problems of motivation as they relate to learning and teaching, a concluding section will be presented in which various suggestions will be made that pertain specifically to the classroom. Classroom motivation may in some instances be relatively easy to provide and apply. On the other hand, in the vast majority of cases the complexity of the individual's background of experience and the interrelationship of motivational factors make it apparent that intelligent attention on the part of the teacher to this important aspect of human behavior comprises a major task. Classroom teaching and pupil learning cannot be simply a matter of presentation of materials to be learned. The introduction of incentives, the development of motives, and the utilization of motives provide opportunities for the teacher *to teach;* their employment in learning marks the chief difference between a teacher and a textbook, or between a good teacher and a poor teacher. Simple all-or-none rules of motivation cannot be set forth. Suggestions can be offered which may be

utilized advantageously by the teacher in light of the learning situation and of the individual learner.

Motivation, needless to say, may be dangerous as well as useful. Care must be taken to avoid certain dangers that have been pointed out from time to time. One such danger lies in the administration of punishment for failure in connection with learning. It is evident that the effects of punishment on different individuals are not uniform and that there are many instances in which punishment is not only undesirable, but in which it results in an opposite effect upon the learning activity from that intended. Before punishment is applied, the teacher should make certain that it is an appropriate incentive in the particular situation. School work, for example, should never be utilized as a means of punishment; the unpleasantness of the punishment situation may easily extend to the school work engaged in, subsequently leading to the development of a negative attitude toward similar materials.

Another danger which has sometimes been pointed out is that of the learner working *for* the incentive. Many educators have felt that the only worth-while motivation is so-called 'intrinsic' motivation and that emphasis upon the end (an incentive) rather than on the means (the learning) of attaining the end is undesirable. Statements regarding the desirability of extrinsic versus intrinsic motivation are, of course, largely matters of opinion. It may be true that intrinsic motivation is more generally and permanently effective than is learning for some material reward. However, it is the behavior that is being acquired, the learning that is taking place, that is most important. So long as the desired learning does take place and becomes available for application in the individual's life activities, the incentive which was used to stimulate the learning is, perhaps, of relatively little significance. That is, so far as the learning itself is concerned, it may matter little that the incentive was a material reward, praise, or simply satisfaction in doing a job well; the incentive itself drops out of the immediate picture, and the pattern of behavior which was learned becomes the important feature of the individual's experience.

The danger and undesirability of employing competition as a motivational device has also sometimes been pointed out. The line of argument follows that rivalry and competition are acquired social responses, that they are incompatible with a democratic philosophy, and that a better way of life may be provided through the substitution of an ideal of coöperation for competition. Certainly, coöperation is desir-

able; equally certain is the fact that an extreme 'dog-eat-dog' philosophy is out of place in an enlightened society. It is not unreasonable, however, to assume that a certain degree of competition is acceptable in learning situations and that it does not necessarily negate the teachings of democracy. A realistic view might attempt to reconcile rather than mutually exclude competition and coöperation. Competition *does* affect learning. The situation involving rivalry is conducive to greater effort on the part of the individual. Nevertheless, competition among students in classroom activities probably should be used with discretion. The most acceptable form is undoubtedly self-competition, in which the individual strives to better his own previous record. In such a case individual initiative is at a premium and the motivational effects of competition may be taken advantage of without, at the same time, introducing the social problem involved in competition with one's fellows.

A decade ago Monroe and Engelhart (46), in surveying the ways and means of stimulating learning activity, listed the following devices which they believed should be employed less frequently and with caution in motivating school work: (1) informing the pupil of failure in learning; (2) arranging competitions; (3) administering reproof or punishment; (4) awarding prizes, honors, and other distinctions. These authors further warn that the teacher should use motivating devices judiciously; that mere activity on the part of the learner does not insure learning, but rather that the teacher must stimulate the 'desire to learn'; and that teachers should be careful not to approach pupils with the assumption that they dislike schoolwork and that extrinsic motivational devices are therefore always necessary.

Briggs (7) concluded, from the replies of college students to his inquiry, that the least effective devices in classroom motivation are sarcasm, ridicule, low marks, extra work as a penalty, and reprimands before other students.

On the positive side, the results of experiments and of observational studies of motivation have contributed a number of cues. Monroe and Engelhart (46), for example, in their survey listed as motivational devices worthy of more frequent use in the classroom: (1) engendering suitable mind sets, attitudes, or moods; (2) acquainting the pupil with definite objectives; (3) informing the pupil of success in learning; (4) testing achievement frequently; (5) commending where commendation is justified; and (6) conferring when a conference will prove stimu-

lating. Monroe and Engelhart emphasized the responsibility of the teacher in creating pupil interest (through community events, extracurricular activities, travel, books, pictures, objects for exhibit, projects, etc.) and in creating student needs (through special projects, laboratory and shop work, and the direction of extracurricular activities in which the student will recognize the necessity of learning certain materials as a means of attaining some broader objective).

Briggs (7) found that students considered most effective such means of motivation as friendly conferences, public commendation, being excused from work as a reward, and reprimands in private. 'Liking the teacher' was also named as important.

In addition to such considerations as those which have just been mentioned and in summary of the whole of the foregoing discussion, the following comments on motivation in the classroom are offered:

(1) Emphasis on 'meanings' and relationships contributes to the individual's set for learning. Materials lacking in meaning are relatively more difficult to learn than those the meaning of which is understood. Meanings may be developed by basing the learning upon the past experience of the individual, by extending and elaborating (or enriching) the basic principles or facts involved, by taking advantage of the logical relationships of the material in organizing it for presentation, and by pointing out possible applications of the learning. Overviews of units of study or materials to be learned at the beginning of the study of new materials appear to serve as effective devices for indicating relationships and providing a facilitating set for the learning to follow.

(2) Interests, attitudes, and purposes must sometimes be developed, or needs created, as a first step in learning. Most of the motives that are effective in the classroom have themselves been learned. It is a teacher's responsibility not only to take advantage of present motives, but also to direct the development of others which may serve useful and desirable purposes. Needs may be created through the introduction of projects which tap a major interest of the individual but, at the same time, demand that he learn a variety of previously unencountered facts or skills in order to bring the task to completion.

(3) Goals and standards to be met function successfully as incentives only when adapted to pupil ability. Individual differences in potentiality for achievement at any given time are widely distributed in a classroom. Care must be taken in making assignments to be cer-

tain that the learning required does not exceed the pupil's ability, on the one hand, and that it is not beneath his ability, on the other. In either event, maximum efficiency cannot be expected.

(4) Definite objectives are necessary if motivation is to be effective. Not only the difficulty of the assignment, but its length and definiteness, as well, are important considerations from the standpoint of motivation. Distant goals, where attainment is more desired than anticipated, are not generally considered to be so useful as incentives as are more immediate goals. Assignments should never be vague; standards or requirements should be definitely stated; and the length of the assignment should be such that it is reasonable to expect its completion. Closeness to the goal is an important factor in learning, and learning behavior is facilitated as the goal is more closely approached. [See Hull (29); also Lewin (40).]

In this connection, the effects of knowledge of results and of recitation upon learning should be recalled. Learning is definitely aided by allowing students to observe the progress they have made. This may be accomplished by various devices such as graphs and charts individually kept, or perhaps simply by providing occasional examinations or tests from the results of which the student may judge his success. Unfortunately for students of lower ability, such devices portray failure as well as success. The usefulness of knowledge of results is generally found to be greatest with average and superior students, whereas its value with students of inferior ability may be negligible unless care is taken to keep the knowledge of results definitely confined to self-progress as much as possible.

(5) Pupil interests are important sources of motivation. It is advantageous for learning to employ existing interests and attitudes in promoting learning. If none exist that can be used, attention should be given to their development. Participation in meaningful activities furnishes a background for the development of interests.

(6) Specific directions and suggestions for learning contribute to the student's set. Directions for learning in a special field of subject matter and the provision of more general 'hints' for the development of successful study habits in all fields serve to motivate learning. Most such suggestions will be of limited value, however, unless the learner uses them, as they are intended, as guides in the building of habits of study which are conducive to efficient learning.

(7) Reward and praise may be effective incentives for some students in learning situations. Commendation, personal attention, and similar expressions of recognition of progress should be used, but these incentives are of dubious value when applied to all persons or when repeatedly used with the same individual. Undeserved praise, or praise which is too frequently applied may not have the desired effect.

(8) Punishment is probably of limited value in motivating learning. The judicious administration of reprimands and punishments may serve as an aid to learning, provided the punishment is appropriate and the possible dangers seem to be at a minimum.

(9) The teacher plays an important part in the motivation picture. Attention should be given by the teacher to personality traits which pupils generally like and others which they generally dislike in teachers. Teachers who are liked and respected themselves contribute directly to the pupil's learning as the pupil seeks to obtain the teacher's approval and to identify himself with the teacher.

(10) The motivation of learning for a given individual may be difficult if an attempt is made to limit the motive or drive to some specific task, set of materials, or school subject. Classroom learning occurs in a larger setting. The whole school situation, often involving extra-school activities as well, contributes to an individual's behavior and unless these more inclusive and broader aspects of experience are taken into account in applying motivation to learning, the teacher's efforts may fail to produce the desired effects.

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CHAPTER IX

THE RELATION OF EMOTIONAL BEHAVIOR TO LEARNING

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I. INTRODUCTION

The learning theories presented in the earlier sections of this book are concerned primarily with the problem of the organization of behavior patterns in concrete situations. They seek to show why we remember one word rather than another, how we attain skill in arithmetic, spelling, or reading, how control of a golf club or of a baseball bat is achieved, how problems are solved, how concepts or principles come to be understood, etc. All of these can be viewed as the attainment of proficiency or mastery within a more or less circumscribed area of the individual's life experience. In some degree, learning theory also takes account of the manner in which acquired patterns transfer from one situation or circumstance to another. It has been, however, but little concerned with the inter-relationship of learnings to one another and their contribution in a broad sense to the whole process of adjustment.

When the term *learning* is used in the narrow and traditional sense, the emotions are viewed as driving mechanisms. When learning is treated in this fashion, the relation between the emotional level at the moment and the facility with which a particular pattern is acquired is discussed. Here concern centers about the effects of various motivating factors, drives, goals, etc., as well as the effects of specific incentives upon the acquisition of competence in particular domains. There arises also the problem of the inhibiting or facilitating effects which emotions, arising either antecedent to or during the process of learning, may have upon the learning itself. Finally, the end results of the learning process can be viewed as producing their own characteristic emotional responses. Separating emotion and learning in this way serves a useful

purpose only if one constantly remembers that our observations are made upon a human being who reacts as a unified whole to a particular situation or to a series of situations. Learning and emotion are then merely terms used to classify and describe a unitary process—the adjustment of the organism to its environment.

In its attack upon learning, association psychology was primarily concerned with the problem of the stamping in of connections and limited itself rather closely to connections within the area of verbal learning, i.e., memory. In time, as observations were made on the acquisition of skills in situations such as the maze or the puzzle box, more attention was paid to the organization of behavior. With the introduction of the concept of trial and error learning, the problem of the selection and elimination of responses came to the fore. Conditioning theory first developed about skills which are exceedingly narrow and restricted when viewed from the standpoint of the organization of behavior. In time, however, as more emphasis was placed upon the state of the organism as an important factor in the process of learning, these theories were broadened into a wide-ranging explanatory system. The state of the organism as thus conceived begins with physiological needs and appetites and ultimately extends to the whole complex series of emotions, attitudes, and tendencies that characterize human behavior in a social world.

If the earlier chapters in this volume were to be characterized in terms of their relation to emotional theory, it would be necessary to say that in Hartmann's chapter no attack is made on this problem of interrelationship, since it is so exclusively concerned with perceptual learning. In Guthrie's chapter a point of view is presented that harmonizes quite closely with some aspects of modern emotional theory. Guthrie recognizes that the cat in the puzzle box is in a disturbing situation from which eventually a terminal reaction brings relief. Because of its terminal character, this reaction becomes fixated. The factors initiating it arise either in the environmental stimuli or in the state of the organism.

Hull's principle of behavior variability or the oscillation in response which arises through irrelevant stimuli in both the external and the internal environment, is especially significant for that type of adaptation which occurs under emotional stress. He outlines the manner in which selection and fixation occur by reduction in the need of the organism through adaptive behavior and describes the mechanism by

means of which the pattern of adaptive behavior arises out of behavior variability. While he does not discuss emotional adjustment in detail, his explanatory system covers it quite as well as it does the adaptive behavior appearing in more traditional learning situations.

Sandiford limits his discussion of Thorndike's position to the classic problem of the fixation of response, while Gates, in addition, emphasizes progress toward a goal and gives a description and analysis of trial-and-error behavior that with slight modification might be carried over to emotionally weighted situations. The differences between a terminal response that closes a disturbing situation (Guthrie), the reduction of need through adaptation (Hull), or the law of effect (Thorndike) are slight for emotional theory. Any one of these concepts could be incorporated into the analysis of emotional behavior.

Lewin is so much concerned with the cognitive aspects of the problem of learning that he closes his discussion at the point at which he begins to come to grips with the problems faced by Thorndike, Hull, and Guthrie. For it is precisely at the point where skill gives mastery of the situation, in terms of action rather than cognition of it, that the important problems of the relation of emotion to learning lie. In the frustration experiment of Barker, Dembo, and Lewin (2) the experimental set-up permitted no solution to the problem presented to the children. Therefore, no organization of behavior on a permanent basis could take place and no learning, except in a maladaptive sense, occurred. Hence, no problem of the fixation of correct response arose. While Lewin assumes organization and pictures its successive phases with great skill, he does not concern himself with the mechanisms through which elimination and fixation occur, a problem of fundamental importance. Nevertheless, for Lewin, emotional behavior and learning are in the same universe of discourse.

As psychology has advanced, the problem of the organization of behavior, with which the learning theorists are so deeply concerned, has also become the central problem of the attack upon the emotions. In fact, the striking progress of the last three decades in our knowledge of emotional behavior stems out of the shift from the classification and description of emotions and feelings as discrete experiences to a consideration of their function as adaptive and adjustive mechanisms. Increasingly it has become clear that the individual emotional experience is only a step in an adaptive process that carries the organism from diffuse and unorganized behavior to specific and organized behavior. If

this point of view is correct, and we have every reason to suppose it so, a theory of learning should account both for the structuring of behavior and the selection and fixation of the final pattern, whether we consider the learning of nonsense syllables, simple conditioning in the popular sense, the acquisition of a complex skill, the change in behavior resulting from single or repeated emotional experience or, even, the organization of a way of life.

II. Modern Theory of Emotions

William James gave the first push away from the older viewpoint of classifying and describing emotions as discrete experiences by developing what came to be called the James-Lange theory. This theory pictured the emotion as the correlate of a physiological state. It remained, however, for Cannon (4) and his associates, who were led into fundamental research in order to attack the James-Lange theory, to formulate in broad outline what has become basic modern theory. Essentially, this begins with the recognition of the fact that exciting emotions are powerful disturbers of the bodily economy and arise in emergency situations for which the organism is not adequately prepared and for which it lacks specific patterns of behavior. The exciting emotion gains its meaning from its energizing value in the face of the emergency, block, or thwart. Accompanying the emotion and resulting from the energization there is *more varied, more intense,* and *more rapid* behavior. In its early stages the overt behavior is diffuse and unorganized; it may rapidly take on an organized character, or it may, if the situation is too complex, continue at an unorganized level. Essentially, the organism goes through its repertoire more quickly and thoroughly than would be the case if an emergency had not appeared. As a result, a pattern of behavior is more likely to become organized which will enable the organism to meet the situation. In time, on repetition, and as adaptive mechanisms are established, the situation loses much of its original tension-producing quality. During the emergency reaction, autonomic, visceral, and glandular components tend to dominate the picture; with adaptation these components tend to disappear, and in their place come organized skeletal activities. Thus, with adaptation there is a shift from the diffuse activities dominated by vegetative and primitive systems, to the organized and precise activities dominated by the cortex and the central nervous system. The

essential elements of this theoretical position are (1) the emergency situation which interferes with normal activities and throws the organism out of equilibrium; (2) the energization of the organism to a high degree and the mobilization of its resources in order to meet the emergency situation; (3) meeting the situation both as a result of the display of energy and range of activities called forth; and (4) a modification in the individual's pattern of reaction as a result of the experience.

III. Similarity Between Emotion and Learning

If this analysis is considered in detail, it becomes clear that a process closely related to learning is being described. For the emergency situation we can substitute a novel situation or a problem; for the mobilizing of resources we can substitute the repertoire of trial-and-error behavior; and for the adaptation, which includes both selection and elimination, we can substitute learning. The description then parallels that given by many writers for the organization of a skill. Moreover, if the wrought-up character of the organism, i.e., its tenseness and excitement, is regarded as the internal accompaniment of what, to the external observer, appears as trial-and-error or diffuse behavior, the end result either for learning or emotion may be looked upon as one in which both the internal tension and the external variations in behavior are reduced to a minimum. And the exciting emotion can be viewed as a driving mechanism or as a state of tension, the emergency situation as the device which sets off the mechanism or tension system, and adaptation of learning can be thought of as the end result. Thus, skill in meeting a tense, fear-producing situation is learning in much the same sense as is the acquisition of skill in solving a puzzle, or skill in a motor act. It has been shown by Holmes (11) that training the child in a specific response which meets the situation eliminates the emotion of fear.

From the standpoint of the organization of behavior, then, there is an early stage marked by tenseness, random activity, feelings of excitement, etc., and an expert or final stage marked by smooth-running, effective, and competent activity. And in the evolution of behavior, situations which previously produced strong emotional reactions are later met by organized patterns of reaction that are in themselves skills. Emotion and tension then become identified with the early diffuse stages of response, and skill or mastery with the later organized and

overt response systems. In a sense, and within limits, the organism showing an emotion does not *know* precisely what to do; the organism showing skill *knows* exactly what to do.

Or to put it in another way, we can say that the normal equilibrium of the organism is disturbed from time to time by external stimuli or internal impulses which vary widely in intensity and in value for the organism. In actively seeking to return to normal equilibrium, the organism develops forms of behavior that, by avoiding future marked disruptions or disturbances of this equilibrium, will permit it to remain on an even keel. And, in time, the organism moves toward minimal responses in the situations presented to it; that is, it develops those patterns of reaction which meet the situations with the smallest expenditure of effort and the least difficulty. If this view of emotional response is taken, the traditionally sharp distinctions between learning, problem solving, and emotion disappear. Instead, there is left a continuum of stimulating situations which vary through all degrees from intense and violent to small and limited disturbances. In describing reactions to these disturbances, we use terms such as emotion, trial and error, frustration, blocking, tension, etc., for the early reactions, and terms such as skill, knowledge, learned reaction, habits, expert action, and competence, to describe the final and minimal stages of response. From this point of view the skill or knowledge which is the end result of the learning process and which comes late in the time sequence is much simpler and much less consuming of energy and time than are the responses at early or beginning stages.

IV. Emotion Initiates Structuring But Does Not Determine End Results

In a concrete situation, very similar types of behavior in terms of final skill may ultimately develop from apparently dissimilar original emotions or motivating devices. Similarly, disturbances which energize the organism may be grouped in various categories without much relationship to their end results in terms of the organization of behavior. It is this separation between process and result that is often so confusing in discussions of emotion and learning.

As behavior becomes structured, various controls appear which are social in their origin. Through these controls, the individual develops not only the capacity to limit the spread of emotional interference from

one area of his life to another within a short period of time, but also the ability to keep his emotional reactions to various situations in separate categories so that they do not affect one another. This is part of the general process of structuring the whole behavior system. There also develop countless specific responses to varieties of situations, including many types of verbal control mechanisms, symbols, stereotypes, attitudes, etc., that inhibit or limit his emotional manifestations.

V. Approach and Withdrawal Reactions

One other general feature of emotional behavior needs emphasis. The reactions of the organism to stimulating situations can be divided into two broad categories—approach reactions and retreat reactions. Roughly, these can be thought of as correlated with aggression toward the situation and with withdrawal from the situation. With the aggressive type of response, the individual is more likely to go through his entire repertoire of response, and hence is more likely to develop positive and adaptive reactions to his life situations. If the retreat tendency dominates, the repertoire is likely to be cut short and the possibility of developing an effective response is thereby limited and adaptation made less certain. These patterns are so inclusive in their nature as almost to become ways of life in particular individuals. And we may well ask, without finding much in the way of answer, how we can so frame the educational experiences of children that they will try themselves out thoroughly in life situations and, in so doing, explore fully their own possibilities. The mobilization of resources within the individual in order to meet emergencies presents possibilities for the organization of behavior that routine experiences lack.

VI. Maladjustment through Inadequate Response

In some individuals for many situations, and for all individuals in some situations, this transition from diffuse, unorganized, tense, emotional behavior to specific, precise, and organized behavior, does not take place. The emergency, the novel situation, the problem, or whatever we wish to call it, does not lose its intense and stimulating character. It continuously reactivates the organism to produce again and again the original undifferentiated and tense type of reaction, or else is only partially reduced by an inadequate or substitute response such as daydreaming, hysteria, etc., which because of its ineffectiveness, still

permits the original situation to retain its tension-producing character In these instances, we speak of maladjustment, meaning essentially a failure on the part of the organism to structure adequately the field in which the behavior originally occurred, i.e., its failure to build an organized and effective habit system.

Some of the situations to which the organism is called upon to react may be so complex as to be impossible of solution. Under these conditions there will be complete frustration and a disrupted system of response, or the internal reaction may be so intense that no structuring can occur. At the other extreme are situations that arouse no mobilizing or energizing response and so force no structuring of behavior. Between these two extremes lies a wide range of patterns of stimuli in the external environment, together with a wide range of internal impulses that vary from weak to very intense. In general, after an initial phase in which behavior is somewhat disorganized, the first effect of an emotion, whatever its type, is facilitating and energizing. In the absence of already acquired maladjustments, this energizing carries forward the structuring of behavior. In time, however, if no organization of responses that meets the situation in all or some of its aspects appears, the emotion becomes harmful to the organism, which wears itself out or becomes debilitated.

VII. Motivation—Goals—Symbolic Correlates

In the light of this discussion, we can consider the relation of motivation and goals to the learning process. The emotion which characterizes the earliest adjustments of the human being arises in situations in which little or no insight is possible. But for human beings who have gone some distance on the road of development and who have had some success in meeting the demands of their environment, a wide variety of action to any situation is possible. Among these, in addition to overt and direct action, are the language responses which have become symbols for projection from the present into the future. Closely connected with these symbols are the values which are placed upon particular types of conduct by the culture or society of which the individual is a part. Underneath this superstructure lie the primitive impulses and appetites which always carry some degree of primacy in determining behavior. But even these are weighted with symbolic processes and controlled by them.

Hence, when we speak of interest and motivation as factors in

learning, we refer to a very complex set of mechanisms and controls which have many origins and which have been developed and integrated over the whole course of the individual's life. Only with the greatest difficulty, if at all, can they be disentangled. Thus, one child studies algebra because his teacher tells him to, another because his father has stressed its relationship to engineering, another because he is fascinated by the mathematical processes, another because it is part of the high-school curriculum, and so on. In this picture, too, are both momentary incentives, impulses, and urges, with intermediate preparatory reactions which are related to remote goals, and the remote goals themselves. Moreover, the individual's past experience with the particular activity makes a substantial contribution to the picture. Thus, one child has received much group recognition and personal encouragement as a result of his efforts in arithmetic, while another has consistently lacked social acclaim and experienced disappointment. One child has obtained the satisfaction which comes with reasonable competence in an activity and is thereby stimulated to go forward, whereas another with no such luck approaches the future in this area with fear and hesitancy.

One general trend is, however, clear. In the developmental course followed by the individual, he gradually moves from response in terms of the immediately present, to response in terms of symbols that carry derived values separated in time, both forward and backward, from the immediate moment. Motivation tends to shift from immediately present incentives and impulses to remote and goal-seeking behavior. But along with these changes the individual retains his capacity to respond to those incentives and impulses which grow directly out of the immediate moment of time, even though he controls his reactions to the immediate present by inhibiting distracting influences, in terms of the more remote values expressed in symbolic terms.

VIII. Effect of Success and Objectivity

Some generalizations of practical importance are possible. In the first place, it seems clear that competent and successful meeting of situations increases the likelihood of so meeting subsequent situations, while failure increases the likelihood of subsequent failure. Two factors operate. The first is closely related to the repertoire of response, for the successful child is less likely to feel inhibited or restrained in the new situation and so is more likely to go through a substantial repertoire and thus obtain the necessary base for building the new be-

havior. The unsuccessful child, on the other hand, tends to withdraw, or to inhibit or cut short his repertoire of response, and thus reduces the possibility of effective reactions. This negative attitude may become so marked that the child ceases to make any effort in a new situation at all and insulates himself almost completely against outside stimuli.

The second factor is clearly related to the tangibility and meaningfulness of the task. In athletic performances, for instance, there is a specific job to be done; the child sees directly the results of his efforts, he sees both how far he kicks a football and how far his friends and associates kick it. The very concreteness and objectivity of distance in inches or feet, as recognized by himself and his associates, facilitates the learning process and gives reality to the athletic situation and the skills developed therein. In situations which are less definite, real, and tangible, the individual may feel continuously frustrated, even though progress in learning is being made. Thus, a bright thirteen-year-old said that she liked algebra and Latin because she knew when she made a mistake, but that she did not like the course on community problems because no one knew what was right or wrong. Here the child is expressing a need for clearness and tangibility in the learning situation, even though she is making substantial progress in social studies. Although many of the learning situations that become the basis for the learning theories presented in the earlier chapters of this Yearbook clearly possess the quality of tangibility, it is clear that in those situations heavily weighted with emotion, a clear and tangible result is not so easily attained by the individual. Perhaps, if it were, there would be little or no emotion.

This lack of tangibility which characterizes emotional behavior has also affected the securing of adequate experimental data and theory. In their nature, emotions result from blocking and are emergency reactions. In the disorganization of behavior that follows, the particular emotions that will arise are to some degree unpredictable for the individual. The emotion that appears is dependent upon both the general state of the organism, and its immediately preceding emotional experiences. Thus, a child's behavior in school may vary widely from day to day if he is under strong tension, or on any particular day it may be affected by a particular emotional experience at home or on the playground. Under some conditions, as a result of intense or violent stimulation, behavior is organized so rapidly that it becomes fixed with

a single experience and may persist in pattern form for weeks or months. Although the classical instance is found in the conditioning of fears, equally good instances can be found for anger, love, etc. And often in an emotionally-ready person, a single word, gesture, or incident, may produce results out of all proportion to the stimulus presented. But under quite different circumstances or in an organism with a different state of readiness, similar stimuli may be presented over and over again without outward effects. Sometimes emotional behavior is organized rapidly, sometimes slowly. With most skills and with a substantial part of our knowledge, learning takes place slowly and is closely patterned about the stimulation. With emotions, however, the patterning of behavior varies according to the functional situation, the state of the organism, and the context.

IX. Facilitation and Frustration

There is a very delicate balance between the facilitating and the frustrating effects of emotion. In their early stages and after the phase of momentary disorganization, emotions are facilitating. But if blocking continues for some time, the organism becomes frustrated and what may have been behavior well on the road toward the solution of the problem presented by the situation, now becomes disorganizing and even may hamper effective reaction. In the experiment of Barker, Dembo, and Lewin (2), a frustration situation was produced for young children by exhibiting a most attractive playroom behind an impassable barrier. The only possible reaction was a return to previous activities. The majority of the children showed a progressive deterioration of behavior in a situation in which behavior had previously been at a high level. But several children seemed to be keyed up by the frustration and showed behavior at a more advanced level. Thus, for some, blocking may be facilitating for a time and then frustrating; for others it may be frustrating from the outset; and for others even prolonged blocking may facilitate reaction. For most persons, however, prolonged blocking produces an extreme disorganization of behavior.

Under milder emotions and less crucial situations, learning goes forward rapidly and smoothly. With very intense emotions and more crucial situations, learning may either occur with great rapidity or not at all, i.e., result in disorganization. The practical problem then is that of creating a degree of tension and excitement which will facilitate learning, while at the same time avoiding such an extreme degree of

tension and excitement that disorganization of response occurs. A similar principle holds for all motivating devices. There is an optimum level of impulse or incentive which leads the organism on to effective learning. Below this level there is ineffective learning because of apathy or indifference; above this level the emotional accompaniments of the impulse or incentive are so intense that the smooth course of learning is disrupted. A skilful teacher is aware of this relation. She keeps her eye on the progress of the children. Moreover, she adapts her methods to the individual child and, in general, understimulates the high-strung and excitable child, and overstimulates the apathetic and unemotional child.

X. Openness of Personality

Out of the child's experience in frustrating and blocking situations there come habits or dispositions which constitute permanent trends in his approach to specific learning situations and to life's problems as well. While these tendencies certainly have some basis in hereditary dispositions, nevertheless there is substantial evidence that emotional behavior is modifiable through wide ranges, particularly if appropriate training is given before the child's pattern becomes too well set. Thus, one child is optimistic, another pessimistic. One child faced with difficult situations becomes a 'money' player and increases in effectiveness under tension, while another becomes tense and disorganized if the going is tough. Some children and adults show an amazing capacity to bounce back from defeat and disappointment, while others carry their defeats and disappointments forward for long periods. Some children face new situations with freshness and spontaneity, while others are limited or restrained in their responses by carry-overs from earlier emotional experiences. Despite their great significance for behavior, we know little of the factors that produce these variations in individuals.

But modern theory distinguishes between the open and the closed personality. By an open personality is meant one with the capacity to face situations afresh without hampering tendencies from the past, coupled with the ability to meet reality and to bounce back from untoward experiences. This also includes a retention of adjustive capacity, since the absence of emotion and enthusiasm (which might be conceived as the goal of perfect adjustment in a fixed environment) is of little or no value in an environment of marked change, such as ours,

which continuously presents new situations. By the closed personality is meant the person who has withdrawn from life's struggle, who meets situations rigidly in terms of old patterns, who carries forward into new situations interfering attitudes, who insulates himself against life and its problems.

An educational program is not only concerned with the learning of specific skills; it is also substantially concerned with a program of emotional education. It should be concerned with providing the child with experiences in surmounting difficulties, in giving him the satisfactions which come with achievement, in furnishing him examples of interest and enthusiasm, and in supplying him with some feeling of security and belonging in order to preserve in him some degree of that curiosity, zest, and spontaneity that characterizes young children, and at the same time develop in him the persistence and goal-seeking capacity of the older person.

XI. Attitudes

As a result of his contacts with life in all its phases, the child builds up a wide variety of ideals, prejudices, beliefs, etc. These can be grouped under the general term *attitudes,* and defined as systems of ideas or symbolic patterns which have become weighted to a greater or less degree with emotional content. There is a continuum running from the skills and knowledges that are completely externalized and carry a minimum of emotional tone to those patterns of behavior and associated symbolic systems that are almost completely internalized and carry such heavy emotional weight that even very slight stimulation will set off a marked reaction. These attitude systems are intimately related to values and goals and to the symbols which function as carriers or stereotypes for values or goals. Attitudes vary markedly from individual to individual in accordance with the particular experiences each has had in meeting situations and in coming under the influences of his associates and contemporaries. The systems of values, which, with their associated stereotypes, exist in every social group, place each individual under pressure to conform. Often individual attitudes come into direct conflict with group values; sometimes within a single individual the valuations imposed by different groups come into conflict. It is not our purpose here to discuss the principles of attitude formation and of conflict solution in detail, since our space is limited. But it is important for the teacher to recognize that, as a

by-product, every form of learning develops a substantial series of attitudes, and that this by-product is often of much more significance for adjustment than the primary skill being taught the individual.

XII. Emotional Outlets

One outcome of experience in life situations is the preservation within the individual of many inadequate and ineffective modes of meeting situations. If the child develops a response system that meets the situation and so eliminates its tension-producing character, he moves on to other similar or even different situations without personality disintegration. But the possibilities of direct and complete solution are limited in a complex and changing life pattern. Hence, various devices for reducing tension, cushioning the situation, or restoring partial equilibrium come into being. These vary from socially acceptable recreational outlets and hobbies, to socially unacceptable and disintegrating forms of behavior. The literature in the field of behavior problems, personality maladjustment, mental hygiene, and psychiatry, describes many devices, such as rationalization, sublimation, flight from reality, the development of peculiar abilities, hysteria, or the development of physical disabilities, which are in essence learned patterns of behavior. They vary widely in their seriousness and their effects upon subsequent behavior. In general, however, it may be said that the human being seldom solves his problems by fleeing from them, and that subterfuges should be recognized and their use discouraged.

Since verbal command and prohibition are decidedly ineffective, the problem for the teacher in modifying behavior becomes one of so setting the stage, in an atmosphere of encouragement and confidence, that the child can find his way to essentially adaptive behavior. This involves, first, the recognition of tension-reducing devices when they occur; second, the analysis of the relations of the child to his context or environment; and, third, the careful and serious consideration of the means by which an essentially normal attack may be made upon the problem faced by the child.

This approach is radically different from the traditional one which looked upon an emotion as an outburst of the moment rather than as a stage in an adjustment process. In times past, we merely looked upon untoward aggressive behavior in the child as 'aggressive behavior'; now we ask "What produces aggression?" and look for, among other things, overrigid discipline, rejection by a parent, or some such dis-

turbance in the context of the child's life. Frequently we find that by reducing the pressure upon the child, the untoward behavior disappears. And it is becoming clear that the teacher is herself an important feature of the child's context; her rigid system of discipline, for instance, may be producing emotional outbursts on the playground and even the hazing of less favored children.

Both children and adults, blocked on the road to direct expression of their emotions or faced with situations that are so complex they cannot be resolved, reduce their tension and achieve a partial adjustment through substitute or outlet mechanisms, which are often quite devious. So interrelated are all aspects of emotional behavior that the effects of tension in one area or phase of the child's life may appear in a quite different area or phase. Although the recognition of outlet mechanisms is of great importance in the individual case, an important aspect of education is the development of socially acceptable emotional outlets for future use—on the assumption that conflict and difficulty are parts of the life process and that the teacher has some responsibility in preparing children to meet them. Thus, a child given extensive musical or dramatic training has a more effective outlet available for draining off tension than that afforded by merely weeping or becoming hysterical. An athletic contest drains off emotional tensions more effectively than miscellaneous and unorganized fighting on the playground. A good hobby, especially one in which the child actively participates and which gives him some skill, is a more effective outlet than breaking windows, street fighting, etc.

Three questions which can be asked then in connection with every educational process can be used in summary of this discussion of emotional outlets. The first is, "Precisely what skills and attitudes is the child acquiring in my schoolroom?" The second is, "How can I, as a teacher, lead the child to a direct attack upon his problems in order that he may develop the habit of facing reality?" The third is, "Recognizing the inevitability of conflict and emotional tension, how can I, as a teacher, so train the child that his cushions against the rigors of life will be socially desirable and enhancing to the personality?"

XIII. Age Relations of Emotional Responses

As children grow from birth to maturity, marked changes occur with age in emotional reactions. The most obvious instance is that of the changes in attitudes toward the opposite sex which accompany puberty,

and which are associated with known physiological and glandular changes. But there are other significant and important changes. Young children show a peak of negativistic responses between two and three years of age which decline sharply in frequency and commonness up to the age of five or six. Some students of this behavior feel that negativism arises because life presents the young child with many complex situations at a time when he has so few effective reaction patterns at his command. As children gain skill in language, in motor activities, and in intellectual pursuits of one type and another, both the need and the occasions for these emotional outbursts disappear. Fears decrease rapidly with age in early childhood, and are manifested in connection with different objects as the child grows older (22). Anger manifestations and temper tantrums follow somewhat the same course as negativistic responses (9). Dysinger and Ruckmick (5), in a study of children's emotional reactions to motion pictures, found a peak of responses for thrill or danger situations at nine years, with a gradual decrease to sixteen years. For scenes involving love making and erotic stimulation, the low point was at nine years and the peak at sixteen. In general, since somewhat less reactivity in most situations was shown with increasing age, it is suggested that the growing individual as he matures builds up some capacity to discount or to inhibit emotional expression and response. It is important, then, to give some consideration to the child's developmental level in working out curricular demands and the conduct of classroom teaching. Thus, for younger children, there are decided advantages in utilizing material with dramatic appeal, while for older children with more definitely structured interests, such appeal is less necessary.

XIV. Level of Aspiration

In recent years a substantial amount of research has been done on what has come to be known as the level of aspiration (1, 6, 7, 8). It is found that children and adults enter learning situations with very definite conceptions of what they should or can do, and that they regulate their performance and their feelings of satisfaction or dissatisfaction in accordance with this level. Feelings of frustration and inadequacy develop in some individuals in terms of this level. The level of aspiration is the performance level or goal which the individual sets for himself in the specific task. By appropriately designed experiments, actual performance can be compared with these goals. Some children

characteristically enter learning situations with very high levels of aspiration, and find even substantial attainment frustrating, while others enter learning situations with such a low level of aspiration that even moderate attainment is more than satisfying. Some children have levels out of all proportion to their possibilities; for others the levels are so low that minor accomplishment satisfies. In individual children the level of aspiration is the resultant of many complex factors which include not only personal and emotional characteristics, but also the social influences coming from elders and contemporaries.

From our point of view, the aspirations of the child are of interest, not only because of their effect upon his performance in the concrete learning situation, but also because of their emotional aftereffects. In some instances, levels of aspiration are distinctly compensatory and represent emotional outlets. In the classroom, it is important to keep the levels high enough for adequate motivation, but not so high that unfortunate and disturbing emotional aftereffects arise. Too much stress upon prizes, competition, grades, etc., often produces such aftereffects. But it is also important to see that the child is occupied with meaningful and significant activities in order that, through them, he may arrive at a fair assessment of his abilities and possibilities.

Not unrelated to the question of levels of aspiration is that of the effect of failure and success upon the child, which has already been mentioned. Under conditions of continued failure in all areas of his life, the child is likely to become either very 'hard-boiled' and well insulated against life, or extraordinarily sensitive and desirous of protection. Hence, it is well to recognize the principle that every child needs for his own well-being some experience of success and some of the social acclaim that accompanies accomplishment, even if the teacher has to go far out of her way to find an area in which these feelings can be engendered. Success in one area may more than compensate for failure in many areas; some accomplishment furnishes an integrating center about which the personality may be integrated. Continued and all-pervading frustration over a substantial period of time affects all phases of learning; an opening in the wall of frustration gives the individual an opportunity for growth and development.

XV. The Effect of the Emotional Context

The child does not grow in isolation, but in a community of fellows and elders. From his earliest years he is observing the emotional dis-

plays of other persons, and their reactions in complex situations, and is himself reacting to this behavior on the part of other persons. He learns much in the way of emotional control from his parents and from his teachers. Hagman (10) found a high positive correlation between the fears of young children and the fears of their mothers. In a group with other boys, a boy will not show fear; off by himself in a similar situation, he will show fear. In the group, the child imitates in some degree the emotions of those around him, shows both sympathetic and emphatic reactions, and receives substantial amounts of direct and indirect instruction in controlling his emotions.

If this be so, the teacher in the schoolroom is herself a 'social stimulus' for her children and the most important single factor in creating the 'emotional atmosphere' of her schoolroom. If she is well-balanced, has poise, and shows good emotional adjustment, some of her balance, poise, and control will be communicated to her children and improve their learning. If, on the other hand, she is high strung, nervous, tense, and poorly adjusted, some of her tension will be communicated to the children and will adversely affect their learning. Once this important relation is clearly grasped, the teacher can take explicit steps to improve her techniques of handling children and deliberately seek the conditions most favorable to learning.

The teacher is also the dispenser of praise and blame, reward and punishment. Through commands and requests she leads her children. Johnson (13), in experiments on a wide range of tasks and activities, has shown that positive, unhurried, specific and encouraging types of directions lead to much more accomplishment by children than do negative, general, hurried, and discouraging directions. The conditions most favorable to learning, then, involve not only the specific tasks set the children by the outlined curriculum, but also the emotional and social interrelations of the group of children, and the skill and poise of the teacher.

XVI. Conclusion

In this presentation, the essential similarities of the phenomena of emotion and those of learning are pointed out. Both are aspects of the same process of adjustment to environmental situations which the organism is continuously called upon to make. In the concrete situation there is only a child who, at the same moment, is learning and showing emotion. In some contexts the organization of a pattern goes forth smoothly and by small increments with a minimum of internal

disturbance; in others it is greatly speeded or retarded with a maximum of disturbance and of internal and organic accompaniment.

From the diffuse, unorganized, and ineffective responses of the novice come the smooth-running, effective, and well-organized responses of the expert. In this process of mastery, which is never complete, the child gains control of his emotions and establishes the skills which enable him both to anticipate future situations and to react appropriately when they occur. The process is facilitated by the use of symbolic devices, even though these prove disturbing in some relations and sometimes create further emotional difficulties.

Both in the organization of its curriculum and its practices within the four walls of the schoolroom, the educational institution should take account, not only of the direct contributions it makes to the child in providing for the acquisition of skills and knowledge, but also of the indirect contributions it makes in guiding the development of attitudes, points of view, goals, and ideals. Through learning, the child moves through a succession of contexts to integrated and well-organized behavior and acquires mastery over his environment and control over his emotions. However concrete and specific our approach may be to the problem of learning, we must not lose sight of the fact that learning is a part of a much larger and more significant adjustment process, in which emotions play an important role. The organization and development of a program for the education of the emotions is a major task, which should be faced both by the school as a whole and the individual classroom teacher, if we are to provide for the all-round, wholesome development of the children entrusted to our care.

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CHAPTER X

THE ROLE OF PRACTICE IN LEARNING

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I. Relation of Practice to Theories of Learning

The old maxim *practice makes perfect* is a mixture of truth and error. By practice is meant performance or some number of performances. It is customary to speak of performances as repetitions or trials. The term *repetition* so used is not intended to suggest that the successive performances are exact duplicates of each other. Exact repetition of an act probably does not lead to improvement. If the character of successive performances does not change in any respect, learning, by definition, does not take place.

1. Practice as a Condition of Learning

Practice is a necessary condition to learning but not a sufficient condition. Some species of practice make perfect; others are wholly unproductive. The tremendous amount of practice necessary to the attainment of a high degree of artistry in any field is common knowledge. Notwithstanding, there are those who insist that learning is not accomplished by practice. What they seem to object to is certain of the theories that purport to explain how learning is achieved by practice. Needless to say, the rejection of an explanation of an event is not tantamount to the abrogation of the event.

Just as it is a half-truth to say that practice makes perfect, so is it a half-truth to say that learning is not accomplished by practice. The two statements are the complements of each other. It is the fact that each is only a half-truth that permits the other to be a half-truth also. There is experimental evidence that, in the course of practice, performance may prosper, remain the same, or grow worse. From this we may infer that it is the practice or repetition of certain conditions that produces a favorable or an unfavorable result; or, that practice

provides for the putting of these conditions into operation. Five repetitions of conditions *a, b, c,* etc., favorable to learning, are of greater consequence than four. Those who aver that we do not learn by practice probably mean that we do not learn by sheer repetition. This construction is quite in agreement with the facts. Practice, even a vast amount of it, does not guarantee improvement in a function.

The foregoing is implicit or explicit in the literature of associationism of the last 200 years. Thomas Brown recognized the role of frequency of practice in his law of relative frequency. That he also recognized that frequency is not a sufficient condition of learning is attested by his eight other laws. Meumann reflects the same idea in his treatment of the will to learn, as did Thorndike in his discussion of the laws of habit, of which the following is an excerpt:

> The law of habit is supposed to be that 'practice makes perfect,' or that the nervous system 'grows to the modes in which it is exercised.' But practice without zeal—with equal comfort at success and failure—does *not* make perfect, and the nervous system grows *away* from the modes in which it is *exercised with resulting discomfort*. When the law of effect is omitted—when habit-formation is reduced to the supposed effect of mere repetition—two results are almost certain. By the resulting theory little in human behavior can be explained by the law of habit; and by the resulting practice, unproductive or extremely wasteful forms of drill are encouraged (40).

Locke voiced the same notion when he wrote: "Attention and repetition help much to the fixing of any ideas in the memory; but those which naturally at first make the deepest and most lasting impression are those which are accompanied with pleasure and pain" (25).

2. Frequency of Repetition and the Laws of Learning

One of the things meant by practice in psychology is repetition as envisaged by the *law of relative frequency* (Brown) or the *law of use* (Thorndike). Thorndike now states in various books published within the last decade that mere repetition, repetition in itself, does little or nothing to increase the probability that a given response will follow a given stimulus. "If a certain state of affairs," he says, "acts upon a man ten thousand times, he will, so far as any intrinsic action of the ten thousand repetitions is concerned, respond in the same way to the last thousand as to the first." Whether or not in his earlier writings he

meant that frequency, *qua* frequency, had any efficacy, the writer is not entirely certain. At any rate the phrase *other things being equal* appeared in his early statement of the law of use.

In much of the theorizing that followed, attempts were made to give a neurological explanation of the law of use by the supposition that repetition lowered synaptic resistances. Whereas innate behavior was thought to be owing neurologically to an inherited condition of lowered synaptic resistances, acquired acts were thought to be brought about neurologically by a lowering of resistances by practice. Thus repetition, *qua* repetition, could by these suppositions be assigned an explanatory role. This conception implies that connection-forming is a gradual process and as such agrees with the empirical fact that learning is gradual. Each repetition putatively reduces synaptic resistances or otherwise improves the neural connections and thus makes more certain the response upon the instance of appropriate stimulation.

There are certain well-known phenomena of learning with which any theory of learning must agree. Among these are the fact that assignments that cannot be learned in one repetition may be learned in a few or many repetitions, the fact that a positive correlation exists between the number of repetitions of learned material and its retention, that forgetting is positively related to the passage of time and that such material when forgotten may be restored by repetition. These facts are all in accord with the resistance theory. But of course, such agreement, while a necessary condition to a valid theory, does not validate it. Moreover, for reasons which cannot be described here, the theory has steadily lost favor during the last ten or fifteen years.

In his *Psychology of Learning*, 1935, and in chapter i of this volume, Guthrie has proposed an all-or-none principle of connection-forming which is quite at variance with the notion of resistance and gradualness. This is an engaging theory, but unhappily one that is extremely difficult to test experimentally. The task of providing a test case capable of disproving it would be an arduous one indeed. A proponent could always maintain that the proper conditions were not met. (That which cannot be disproved cannot be proved.) Moreover, connectionism in the traditional sense of learning by the formation of highly specific neural bonds has met with disfavor at the hands of certain physiological psychologists. While this situation is not encouraging to the resistance theory, it is not necessarily incompatible with connectionism. As the writer understands the matter, Guthrie

regards himself as a connectionist. The expunging of all reference to bonds and resistances would not affect the status of connectionism; nor would the negation of connectionism alter the role of practice in learning.

3. Practice Viewed as a Condition Rather than as a Method of Learning

Thus, regardless of whether connections are formed gradually and by 'wearing down' or according to the all-or-none formula, or whether or not learning involves connection-forming at all, practice in some amount is an essential condition thereto. Learning is a change in performance in the course of practice; changes that may take place on account of other circumstances, as maturation, injury and disease, and intoxication are not thought of as learning.

Learning envisages both acquisition and fixation. A student practices basketball, newspaper writing, a play, a concerto, a poem, or whatever his curriculum calls for with the view to acquiring and fixing modes of behavior. The higher his level of aspiration the more does he practice. The concept of practice applies equally well to his acquisition of knowledge, discipline, and other equipment of an educated person. By practice the actor commits his lines; by further practice he assures himself of their remembrance.

Practice includes the use of all of the techniques of learning, those by which meaning and the awareness of causal relationships are gained, by which conclusions are reached by reflection, and those by which responses are accompanied with reënforcement and belonging. Practice also includes performances that do not lead to learning and those that do so only in a small degree. The average person practices reading, speaking, writing, ciphering, meeting strangers, and the like, throughout his adult life with but little change occurring in performance, save perhaps a tendency toward greater stereotype. There are numerous instances in the literature of psychology in which evidence of learning from practice is absent or exceedingly small, as, for example, in responses without reënforcement and responses without belonging, that is, without the observation being made that this event has anything to do with that event.

Practice is not synonymous with learning, nor is it, itself, a method of learning. It provides for the operation of the methods, but does not

guarantee their operation. While learning does not go on in the absence of practice, it does not necessarily go on in connection with practice. The remainder of this chapter is devoted to the discussion of the conditions in terms of which the effectiveness of practice varies, as these conditions relate to problems of learning in school.

II. Conditions of Learning by Practice

Educational theorists have promised much. Teachers who see so little result from so great expectation make a good market for those who profess at last to have discovered the royal road to learning. Perhaps nearly all of those whose business it is to teach and those whose business it is to learn will agree that up to the present no easy road to learning has been discovered. Perhaps also those who have given some attention to the nature of ability and the learning process will agree that such a discovery is not in sight. Much of the inefficiency in our schools is probably due to a cause beyond our control, namely, the constitution of the organs of learning. For all our knowledge of circulation and digestion, the normal heart and stomach require about as long to do their work as formerly. There is little prospect that some feat of educational engineering will enable our eyes, ears, brains, and hands to work with twice their present efficiency. Learning is slow and tedious. Much that is learned is soon forgotten. These things are so, not because the teaching is bad, but because the learning apparatus is what it is.

The difference between the best batting team in major-league baseball and the poorest batting team is ordinarily about four percentage points. This fact is meant to suggest that small increments in efficiency are often important. Small increments in teaching and learning efficiency, when considered in the light of a pupil's total career, may be tremendously important.

1. Individual Differences

One of the most obvious facts about learning is that pupils vary enormously in achievement in school. By the study of statistics of grade overlapping—a method that has been used extensively since its introduction by Ayres (1) in 1909—we find that approximately a third of the pupils of a given grade equal or exceed the average achievement of the pupils one grade above, and that about a third equal or fall below that of the pupils one grade below. Similarly, about ten per cent

deviate from their modal grade by two full grades above and ten per cent by two full grades below; about three per cent deviate by three full grades above and three per cent below (23, 35). In a recent investigation Cornell (4) found the grade range of 7-year-old pupils to be from one to six, that of 10-year-old pupils, from two to nine. The middle 80 per cent of the former spread over one and one-half grades; that of the latter, over three full grades.

The differences just referred to are due, to some extent, to differences in amount of practice and, to a greater extent, to the quality of practice. Perhaps the greatest single factor is the ability of the pupils. A matter of considerable educational importance is the effect of equal amounts of practice upon individual differences in performance. The effect of equal amounts of schooling upon performance in school subjects has not been investigated extensively. There is a difference of opinion among authorities as to the proper interpretation of the laboratory studies. Two irreconcilable methods of investigation have been employed—which cannot be evaluated here; but it can probably be said that equal amounts of practice increase rather than reduce individual differences in performance in school subjects and in most other complex learning activities. Nor is there, in a practical sense, much probability of eliminating individual differences or reducing them greatly by inducing the poorer students to study more than the better ones. The pupils in the highest 25 per cent probably learn more, understand more, and remember more from one hour of study than do those in the lowest 25 per cent from three or four hours of study. Indeed the former may attain levels of understanding and appreciation that are virtually unattainable by the latter. Nor is it to be supposed that individual differences can be reduced by good teaching. In fact, the better the teaching, the greater are such differences likely to be.

2. Character of the Material of Learning

It is common knowledge that meaningful material is learned more readily than meaningless material. So close is the relationship between meaningfulness and learnability that the latter serves as a criterion of the former. It goes without saying that, in the interest of economy, instruction should be meaningful to the instructed—a fact that has in all probability been recognized since the beginning of teaching and learning.

The fact indicated above is of no special theoretical significance in psychology. It does not prove that one system of psychology is superior to another. It does tell us a great deal about the nature of the operations of the mind. Meaningful material is more readily learned than is non-sense material because it permits the greater utilization of past experience. Meaningful material is, as a condition to its being meaningful, learned to an extent to start with. A list of logically related paired words like DOG—BARK and CAT—MEW is, in comparison with a list of paired syllables like KUZ—SOQ and GIH—PEJ, quite easy to learn. To an African Bushman the two lists would be equally difficult. The last sentence but one contains 129 letters which, except for those comprising the nonsense syllables, the reader can reproduce sequentially in writing exactly or with very close approximation after but a single reading.

Sequential reproduction of a dozen detached letters would tax the ability of many readers. But even in the latter undertaking past experience helps. Each letter has a name and a conventional form which the reader well knows. Apart from the four nonsense syllables, the written reproduction of the sentence just referred to reduces to 28 words, with whose meaning and spelling the reader is already familiar. The syntactical arrangement of the words is also fairly conventional. Moreover, the words reduce to a unit of thought. The reader would have none of these advantages in committing to memory the same sentence written in Chinese symbols; yet the latter would be inherently as meaningful as the former.

3. Mode of Presentation

One of the first issues raised in educational psychology was that of the effect upon learning of the sensory mode of presentation, an issue that grew out of the psychological study of imagery. We shall not review the experimental literature bearing upon this subject; but rather shall indicate what seem to be the more important conclusions, as they relate to the problems of education today.

The research indicates that, in general, there are no very important differences with respect to the two principal sensory avenues of instruction, visual and auditory. When conditions are comparable, reading and listening are about equally effective, as gauged by the average scores earned on material so presented. Such differences as appear tend to favor the auditory presentation. For example Young (44) obtained

a small but consistent advantage in listening over both reading at a normal rate and reading for a length of time equal to that required for oral presentation.

It is not surprising that there should be no large differences in effectiveness between the two methods, inasmuch as learning is essentially a 'central process.' Indeed the investigation of Young and the later work of Goldstein (12) show a high correlation between the scores earned by the two methods of presentation. The latter obtained a coefficient of .78 between the two sets of scores; the former, about .60, on the average. (Young's tests appear to have been somewhat less reliable than those used by Goldstein.)

Perhaps the most important conclusion to be drawn from these findings is that expediency should dictate the mode of instruction to be used. For example, the development of the motion picture affords a method of portrayal not readily available to auditory methods. Maps and still pictures constitute other instances.

4. Incidental Learning

The term *incidental learning* is applied to two different learning situations in education and to still another in psychology. Naturally, things said about one of its meanings do not apply to its other meanings, unless it can be shown independently that they do apply. Psychology teaches that incidental learning is notoriously ineffective. On the other hand we know that some of the most effective teaching and learning are incidental, according to one of the meanings of this term. The home, the playground, the neighborhood, and other primary groups stand as our best examples of educational efficiency. In this interlearning that is featured in the primary group there is neither intention to teach nor intention to learn. It is incidental in that it is not purposed, but is incidental to an activity carried out to satisfy some other purpose.

Some of the most effective teaching of the home, of the playground, and of informal social groups at school and elsewhere is incidental in this sense. The socialized recitation also provides some of the features of interlearning that characterize the learning in primary-group situations. Parents probably teach their children a great deal more when they are not trying to teach them at all than they do by their most carefully planned pedantry. Pupils teach each other without intending to do so and much that the teacher teaches is quite incidental to his

lecture notes or his lesson plan. The effectiveness of this kind of learning probably arises not from its incidental character but from the fact that the situations and responses center about aspects of the pupil's life that are important to him. Conditions are ideal for *effect* or reënforcement to get in its work.

There is another usage of the term *incidental learning* in education. The teacher may make the teaching of reading incidental to the teaching of the social studies and vice versa, or the teaching of language incidental to the teaching of science. This teaching is not incidental in the sense that it is unplanned nor is it incidental in the sense in which the term is used in psychology.

Incidental learning in psychology has usually stood for that learning which takes place as a result of a repetition of a list or the execution of an act when the subject is intent on something other than learning. Myers sought to make a test of incidental learning by dictating a list of words to groups of pupils ostensibly as a spelling test and comparing their retention of the list with that of a comparable list similarly dictated but introduced as a learning exercise (28). Jenkins provided an interesting arrangement of this test in the following manner: One group of subjects acting as experimenters read aloud a list of words to the several members of another group acting as subjects (19). The former group was set to read; the latter, to listen and learn.

McGeoch defines incidental learning as "learning which apparently takes place without a specific motive or a specific formal instruction and set to learn the specific activity or material in question" (27). As an illustration he calls attention to the fact that a subject does incidental learning when, set to learn a list presented on a memory drum, he also learns that the hood of the drum has a crackle finish, or learns other facts about the fabrication of the drum, the furnishings of the room, or the attire of the experimenter. In order to achieve these instances of incidental learning it is necessary that the subject have observed them—reacted to them. In this sense there is nothing psychologically peculiar about incidental learning save the fact that it is pretty much accidental. It is a matter of chance whether or not the subject will make the necessary reactions to the various items that are incidental to the experimentally defined task. There is little doubt that by instruction such learning could be brought from an occasional chance occurrence up to an almost certain occurrence in each subject.

Here then is seen the principal limitation to incidental learning and

the principal advantage in motivated learning. The appropriateness of Horn's remark that anything worth teaching should be the object of planned instruction becomes apparent. We may guess that those enterprising teachers who have achieved good results with the so-called incidental teaching of English, for example, have not left the learning to chance, but have made very careful provisions for it. Perhaps the chief psychological advantage in this type of teaching is that it provides excellent conditions of motivation. Instruction may be given in connection with a need arising from a natural situation. Not only does this situation provide effective motivation but it also insures that the learning will be done in a situation in which it is to be used. This discussion ties in with one of the most important facts of learning, namely, that unmotivated practice is notoriously ineffective.

From the foregoing we may judge that good incidental teaching of spelling, handwriting, English usage, number facts, and the like is not incidental according to the psychologist's meaning of incidental learning. Moreover, existing psychological experimentation may not be used legitimately as an argument against the best practices in incidental teaching. Psychologically, the important condition in the teaching of these subjects is that there should be a spelling consciousness, a writing consciousness, a number consciousness—a set toward improvement and ultimate mastery. Whether they shall be taught directly or 'incidentally' is in part an administrative matter and in part a matter of the skill of the teacher. The reader is referred to articles by Cornman (5), Gates (10), and Horn (17) on spelling, and by Henry (15), Kirkpatrick (22), and McConnell (26) on arithmetic.

5. The Question of Drill

It is but natural that those who have a new idea to sell should make the most favorable contrast possible between their product and those products already on the market. A method of doing so is to make the competitors look as bad as possible. This is comparatively easy to do in the case of drill, and, for that reason, has been overdone. In our anxiety over the abuses, alleged and real, we have had a tendency to forget the fact that there are intelligent, constructive uses of drill.

Drill is currently purported, and by some who have been identified with education long enough to know better, to be the handiwork of stimulus-response psychology. There has probably been less drill dur-

ing the fifty-year period since the founding of the first psychological laboratories in America than in any like period in a thousand years. Moreover, *formalism*, the embodiment of the philosophy of drill, disappeared from American education, at the hands of Hall and the Herbartians, well in advance of the advent of stimulus-response psychology. In fact, there has been so little drill and systematic instruction in our schools during recent years that the condition has provoked some criticism on the part of the public. Perhaps the printing press has had as much to do with the reduction in emphasis on drill as has any single thing. Not at any time in this century have theorists advocated drill as the principal means of educating the youth. Drill probably has been overdone in arithmetic. Even here certain influential theorists have for a generation advocated the placing of more emphasis upon the meaning of number and less emphasis on drill.

We are told, too, that stimulus-response psychology and its compatriot *connectionism* have instigated malpractices in the teaching of citizenship. Our schools, under the influence of traditional psychology, are alleged to have developed a race that cannot think, but can only give back the responses learned by rote, or remain silent if the stimulus happens to vary from that employed by the teacher or the textbook writer. Has Dewey lived in vain? Are the *project method*, the *activity school*, the *unit plan*, the *Winnetka* and *Dalton systems*, and the *contract plan* found only in textbooks?

There are innumerable facts and items of skill that go to make up the equipment of an educated person which must be learned by repetition—by frequency, effect, contiguity, vividness, belonging, knowledge of results, and similar conditions. There is no special reason why the male of our species should be called man or why his sex should be called male; or why the numerals and the letters of the alphabet should have the names they do; at least, there are none that help the child learn these names. English spelling all but defies reduction to a system. No plan has been proposed for the rational solution of the typewriter. Such things are learned by a great deal of practice. Nor is it to be supposed that these are the only kinds of data that require practice. Meaningful material also requires it. In our schools drill exercises have represented one means of implementing practice.

In appraising drill as a teaching procedure, it is well to remember that it is not mere repetition but repetition of the conditions of learning that is effective. Drill can be effective, ineffective, or positively

detrimental; spirited or spiritless. Pupils do not necessarily learn just because they engage in drill. There is need of high standards in drill just as there is in student participation in school management or in the socialized recitation. In the best educational practice, pupils are engaged in drill after the need of it has been demonstrated. A 'felt need' of drill is as easy to create as is a 'felt need' of anything else.

Drill should be recognized for what it is worth and no more. Perhaps no one has ever maintained seriously that drill in spelling will teach a pupil to think, cultivate his character, improve his social adjustment, or make him more democratic. Other provisions are made for these aspects of his education. By drill in spelling he does learn to spell. The cultivation of his rational abilities or of his personality, be it ever so well done, is not sufficient to teach him to spell.

Undoubtedly there are many undesirable features of drill work in our schools. It should not be allowed to become monotonous. Excessive and unessential written work should be avoided. Because of its repetitive character, pupils are likely to lose interest in it more quickly than in most other kinds of activity. For this reason the length of such practice periods should be relatively short. It should be a fairly easy matter to demonstrate by an occasional classroom experiment the efficacy of brief, spirited drill exercises.

Drill is at advantage when pupils individually engage in practice at the point of error. Group drill may be considered wasteful of student time on the ground that many students do not require it. However, there are occasions in which this type of drill is justified—occasions in which the frequency of certain kinds of errors runs high. For example, Charters found that of 25,676 running errors in oral language, 71 per cent fell within five classes of errors (30). Symonds has published similar findings of several investigations on errors in written language (39).

Spelling, handwriting, language, and number are subjects in which individualized drill at the point of error is both practicable and desirable. Systematic testing is used to ascertain whether or not a pupil requires special practice and, if so, to locate the aspect of the subject requiring it. These same test results are used to demonstrate to the individual pupil his need of special practice. Cited here as references are a few articles pertaining to these subjects, namely those of Horn (16) on spelling, Guiler (13) on language usage, Lehman and Pressey (24) on handwriting, and Hanna (14) and Stone (36) on arithmetic.

6. Practice and Transfer of Training

What a pupil may learn through practice depends upon his previous learning; and his present learning affects his future learning. Upon every task of the school day the pupil brings to bear the effects of previous acquirement. The ability to understand instructions, to perceive the nature of the problem, and to profit from clarity of presentation or logic of organization is to transfer to a present situation the result of experience acquired in similar situations in the past. Except for transfer, a teacher could not instruct and a pupil could not learn.

Certain educational theorists have disavowed allegiance with transfer. Actually, an examination of their program shows this to be only a verbal divorcement. The end-result of their program is all to the good, because, in trying to get along without transfer they have provided for the most effective use of it. One of the results of a generation of research is the finding that the amount of transfer is a function of the similarity between the activities involved. Moreover, as instruction is made meaningful, as it leads to useful generalizations, another important condition of transfer is provided.

One of the facts clearly indicated by a vast amount of research is that transfer does not occur uniformly. It may or may not appear at all in measurable amounts; and when present it varies in amount and direction. Thus it is seen that acquirements by practice may or may not have useful application. Here as elsewhere practice may or may not lead to significant educational results.

One of the important educational problems of the day concerns the media for facilitating transfer. The meagerly reported investigation of Judd and Scholckow (20) on generalized instruction in target shooting and of Ruediger (32) on transfer of ideals, the recent work of Katona (21), and the very excellent work of Woodrow (41) and Cox (6) on the effect of method of training on transfer, in opposition to undirected practice, are highly instructive and suggestive of further research. The investigations of Hunter (18), Wylie (42), and Bruce (3) on the similarity factor already referred to are of more than passing significance in educational theory. Of great importance is Cox's suggestion that the effect of training in one mental function upon other mental functions depends upon how that function is trained.

Let us consider a few examples. In a series of experiments in which subjects are engaged in making comparative judgments as in shades of gray, length of lines, specimens of handwriting, and intensity of sounds,

it is quite possible that the improvement made in one series of judgments, as a result of practice, will not extend to the others. If, however, in connection with the practice in one series of judgments the subjects are given some highly refined technique for making the judgments more precise, the probability that the training will transfer to the other series should be increased. In connection with almost every good experiment in learning, there arises the question of its educational usefulness. One standard by which its usefulness is tested is the generality of the results. Courses of study are justifiable only if the facts learned permit the student to make generalizations about something; or if the knowledge, skill, attitude, and method may be sufficiently abstracted as to be generally useful in other courses of study or in life outside of school. To the extent that training is generalized it will transfer. Our best examples are in reading, writing, and counting. The only object in teaching a child to count ducks, is to teach him to count, to count anything that can be counted. One of the objectives of the Herbartian five steps was the attainment of generalization. The various versions of the unit plan of instruction, integration, and correlation owe their merit in no small measure to facilitation of generalization.

7. Motivation of Practice

One of the prime determinatives of the efficacy of practice is motivation. Motives, by definition, arouse and direct activity and, as such, are specifics against spiritless, aimless practice. In fact, the principal explanation of the truth that so much practice is valueless is that it is unmotivated. It is common knowledge that a pupil may write a theme a day for a year without exhibiting the slightest improvement in his handwriting. In fact, he may do so without any resulting improvement in his grammar or story-telling ability. Guthrie's assertion that one learns by practice what one practices is apropos. Practice in handwriting, grammatical usage, or story-telling may ordinarily be expected to bring improvement if it is motivated practice, if the pupil is 'set' specifically to improve his performances. In a sense it may be said that improvement in a function may be expected only if the pupil practices doing the function better. The wrong practice tends to fix the wrong habit.

Inasmuch as this volume contains a separate treatment of motivation, the present discussion is limited to a few elementary considerations. In psychological literature two classes of motives are recog-

nized, primary and secondary. Primary motives are conditions that arouse and direct organisms in the interest of satisfying their biological needs. These include hunger, thirst, pain, and similar conditions. Secondary motives are acquired within the lifetime of each individual. Psychologists also make a distinction between motive and incentive. For example, hunger is a motive; food, an incentive. Motives give efficacy to incentives.

Apparently there are no primary motives that move a youth to learn his lessons or a man to work at his vocation. Such efforts are sustained by secondary motives. Perhaps the most universal and dependable of these is what Bain named self-esteem, or what Locke referred to as love of credit and the apprehension of shame and disgrace. It is his vanity, not winter's blast, that normally sends a man to his tailor. Current listings in psychological literature include *mastery motives, social approval motives,* and *conformity motives.* These are some of the motives that a pupil has when he comes to school and which give efficacy to the incentives to learning. They are probably as universal as and as strong as, at times stronger than, the primary motives. They are less dependable only because they are less specific. The only thing that normally satisfies hunger is food. There are many things that will satisfy self-esteem besides achievement in an academic subject.

Among the more important incentives to learning are marks, honors, praise, reproof, rivalry, and whatever in the way of books and other forms of entertainment may satisfy the pupil's interest. At least these are samples of what the teacher has to work with in his efforts to induce his pupils to learn.

A few points of special educational interest may be noted. First, all motives and incentives to practice in school are in a sense artificial. Working for a grade is no more unnatural than working in order to become a useful citizen.

Second, motive-incentive conditions rarely act singly. There is nearly always a certain amount of competition among them. The manner in which an individual will respond to one motive-incentive condition depends not only upon the strength of that condition, but also upon the strength of the competing conditions. This is apropos of Moss's assertion that "the behavior of any animal is the resultant of his drives to action and the opposing resistances." There probably are but few courses of study that can, on the basis of intrinsic interest, compete successfully with the playground, the theater, good fiction, or

the swimming pool. But as courses are made more interesting, the gap between their appeal and the appeal of competing activities is lessened, and the more effectively can the motive-incentive conditions to practice get in their work. One of the most important contributions to education in our time has been the steady accumulation of interesting books and materials of instruction, which have served to remove schooling from the category of a disagreeable task.

Third, there is good reason to believe that immediate motive-incentive conditions are more effective than remote ones. There appears to be little likelihood that an individual will work long toward a distant goal unless he derives some immediate satisfaction in doing so. Thomas's four wishes—recognition, security, response from others, and desire for new experience—are illustrative of the kind of immediate satisfaction derivable from achievement in school. The ideal of preparation for citizenship may not move a pupil much. This should not disturb us. If he wins recognition, security, and response from others and satisfies his desire for new experiences in working at a task that is a preparation for citizenship, he will be willing to work at that task, the end result of which will be preparation for citizenship. The finding of Symonds and Chase (38), namely, that pupils made more progress in English when they worked for improvement in English scores than when they worked for improvement in English as an ideal, is explainable in terms of immediacy of the goal. Marks, honors, and buttons are effective incentives to learning. They are immediate and tangible rewards; they induce rivalry, bring praise and reproof, recognition, security, and response from others. After all, working for marks is only so bad as the marks. They are not any more artificial or ephemeral than felt needs.

Although the writer approves the use of these incentives, he does not wish to appear to give unguarded endorsement to them. They function as effective incentives only to the extent that they have group sanction and esteem and stand for meritorious achievement. Moreover, the element of immediacy of reward is not absent in interest. Interest—in biography, microbes, military tactics, insects, marine life—interest so intense even as to amount to a hobby, is not without ego gratification, as realized in response from others, recognition, security, and the like. The boy who in his leisure time engages in collecting, mounting, classifying, and studying reptiles is probably satisfying the same basic motives as the boy who works to earn scholastic honors. If

the former incentive is educationally superior to the latter, its superiority does not lie in its stemming from a nobler source of motivation.

Fourth, from the standpoint of motivation, success and failure are not absolute, but relative to the pupils' level of aspiration (8). Only those pupils who have some expectation of winning can compete intelligently for awards. Some kind of marks that signify merit rather than defeat should be available to even the poorest members of a class. Mastery motives, social approval motives, and others of this type, together with their incentives, operate most effectively in connection with those activities that have the highest sanctions of the group. Teachers, administrators, and all school functions have need of prestige. They could all profit from more effective advertising than they have had.

Fifth, it is the school's obligation to foster the creation of new interests. Perhaps Dewey has written the most lucidly on this point. He has recognized two principal classes of interests, immediate and mediate. The former "puts itself forth with no thought of anything beyond." The activity is its own end, not a means to an end, in so far as it is rationalized by the individual. Mediate interest is interest in an object or activity as a means to an end. By the normal processes of association a mediate object of activity may, if successfully used as a means of satisfying some immediate interest, become an interest in its own right. If the pupil comes to see the object "not by itself, but as a part of a larger whole," he may acquire an interest in the act by virtue of the fact that it is a part of the whole. "Here, and here only, have we the reality of the idea of 'making things interesting'" (7).

8. Practice With and Without Knowledge of Results

A long list of experiments in psychology has demonstrated the importance of knowledge of results in practice and the futility of practice in the absence of such knowledge. In practice in most school situations, pupils naturally have some knowledge of their achievement, even if not specifically informed concerning it by the teacher. But even here precise information based upon measures whose validity the pupils respect is a contribution to effective practice. For a list of references on the effect of knowledge of results on practice in school situations the reader is referred to a recent article by the author (37).

Knowledge of results serves as a guide to the learner in his subsequent practices and, as such, functions as a basis of selection and

elimination—a characteristic of most complex acts of learning. Knowledge of results is usually treated as an aspect of motivation, and aptly so. While such knowledge is neither a motive nor an incentive, it serves as a vital medium for the operation of the normal motive-incentive conditions. Success in a motivated activity brings reward and ego gratification; failure is a form of punishment. Knowledge of results defines success and failure.

9. Symbolical Practice

In educational psychology, symbolical practice is treated under the heading of recall or recitation, as opposed to practice by response to direct sensory impression, as in the widely quoted experiment of Gates. As is well known to students of psychology and education, certain amounts of symbolical practice have proved to be very effective in learning. Writers have suggested that the interspersing of recall between reading or listening tends to energize the practice and to mediate to some extent a knowledge of results. Certain forms of symbolical practice, as will be indicated presently, may also be quite economical in a temporal sense.

The effectiveness of symbolical practice in learning is not questioned; but its usefulness in teaching and studying ,as not generally been capitalized fully, owing to the absence of techniques for doing so. The writer feels that definite provisions should be made in the school procedure for the exercise of any economy of method of study whose employment seems desirable. If symbolical practice, review, distributed study, or other procedures are to be of material value, arrangements for their use should be made a part of the teaching procedure, not left to the fancy of the student. Some method of inducing symbolical practice when desired and in the manner desired should be brought under the control of the teacher. Effective means of so doing, although not commonly recognized as such, are the class discussion, the mental (subvocal) answering of questions propounded by the teacher or the pupils, and the written examination, especially the objective type. Research by Bridge (2) and Germane (11) has shown the essay examination to be relatively uneconomical as a practice device. This probably comes about as a result of the slowness of the process. Thus the recitation and the examination are to be looked upon not merely as educational devices for ascertaining what pupils have learned; they are themselves effective and economical forms of practice. Recent research has shown

that a recognitive response, as in the taking of a multiple-choice examination, has practice value quite comparable to recall (33, 34).

10. Distributed Practice

It has long since been recognized that there are two aspects to distributed practice, the length of the practice period and the length of the interval between practices. Of the two, the former is of the greater importance, although the greater share of the theoretical treatment of the subject pertains to the latter. The daily scheduling of the lesson insures ample distribution, in so far as the length of interval between practices is concerned. Psychological experimentation has shown short work periods to be more effective than long ones. Subjects do more work per minute when set to work for a short interval than when set to work for a long interval. This fact stands as one explanation of the value of distributed practice and at the same time argues that practice periods should be relatively short in order to insure the maximum in efficiency. This is not, however, sufficient ground for shortening the class period. It means rather that the nature of the function practiced should be changed within the class period. Changing classes entails a good deal of administrative waste. There is a tendency at present to lengthen the class periods, especially in those systems in which they are regarded as work periods rather than recitation periods. In such systems teachers demand more time—time for orientation and the development of a problem, time for investigation on the part of the pupils. Short periods are said to be conducive to teacher-dominated assignments and the giving of pat answers to questions.

11. Amount of Practice

There is no question of the positive correlation between the proficiency of an individual in a function and the amount of effective practice engaged in. However, as indicated in the foregoing discussion, the efficacy of practice is highly variable and it should be clear that the relationship is not of the order of one to one. Each of a number of practices does not contribute equally to the mastery of a task. This we may also infer from the shape of learning curves and from the phenomenon of plateaus.

Related to this issue is the problem of over-learning, by which is meant practice beyond the attainment of a criterion. Practice engaged in beyond arbitrary mastery, as continued practice of a selection of

verse after it has been learned to the point of one correct repetition, is known to benefit retention. The greater the amount of practice, the more thoroughly is a task learned and the more certain is the subsequent performance of it, other things being equal.

These facts should not, without further consideration, be construed as being a substantiation of the practice of intensive as opposed to extensive study. Even in the teaching of spelling, arithmetical facts, and factual information of other sorts, whose mastery requires considerable practice and which resemble rather closely the word-form objects used in the experiments in over-learning, it is not clear that over-learning is superior to review. In fact, we may infer from the facts of distributed practice that moderate initial practice and systematic review should prove to be superior to over-learning. Moreover, in much of the learning in school, the object is not so much to master a particular assignment, a poem, a short story, or a chapter on the French Revolution, as it is to learn something about poetry, the short story, or the French Revolution. That is, the object of learning is to gain certain appreciation, meanings, and facts about a subject under investigation.

From Locke's classical writings on the gaining of conceptual knowledge through experience, and from our knowledge of the development of concepts and meanings in children, we may infer that extensive reading, wide application, and other procedures subsumed under extensive study better serve the end of education than intensive study. This conclusion is supported by experimental findings (31). One of the conditions of valid generalization is the experiencing of a phenomenon in its various contexts, observing its various connotations and relationships with other phenomena. Extensive study of a phenomenon should lead to thorough and dependable understanding.

The distinction between intensive and extensive study is sometimes difficult to draw. What we want is intensive learning—thorough, mature concepts, understanding, and the ability to make application. Many-sidedness in approach rather than repetitive study of a single approach seems best calculated to serve this end. Intensive consideration of a topic seems to require extensive reading and study. Extensive class discussion, of course, accomplishes the same end. Extensive study should not be confused with superficiality.

The intensive-extensive issue is most unequivocally met in the assignment. The pupil may be directed to devote the time at his disposal

for a certain lesson to the reading, rereading and study of a treatment of a topic as found in some one source; or he may be advised to read once—sometimes lightly and sometimes carefully as circumstances require—as many sources as he can. For reasons stated above, the extensive procedure should prove to be superior. There is also another reason, namely, the finding that pupils do not learn much more from two consecutive readings of a selection than they do from one (43).

12. Maintenance by Practice

The two great expediencies used to insure retention are thorough initial learning and subsequent practice or review. No matter how thorough the initial learning is, forgetting is to be expected in time unless subsequent practice is engaged in. Such practice may take several forms, as in rereading material previously studied, using the material in different contexts, engaging in symbolical practice by direct recall class discussion, written examination—essay or objective, and response to oral questions—vocal or subvocal. All of these methods, with the possible exception of the essay examination, have been shown to be effective (2, 11).

The present discussion is concerned chiefly with the relationship between the effectiveness of review and the temporal position of its introduction. Lyon recommended that the first review be engaged in soon after the learning exercise, within a day; and that, if there are to be several review exercises, the earlier ones should be frequent, the later ones, less frequent. In general, educational psychologists have advised the adoption of Lyon's recommendation. It appears from the context of his article that he had in mind some form of symbolical review. Recent research has shown this recommendation to be well-advised in so far as this kind of reviewing is concerned, but only for this kind. That is, if reviewing is to be done by reimpression, by rereading or relistening, its effectiveness appears to be independent of temporal position. At least, no advantage has been found in an early review (by reimpression) (33, 29).

It has been demonstrated that the taking of an objective test has excellent review value. This method is symbolical in some respects, and it is affected by temporal position exactly as is recall. Its effectiveness decreases rapidly as the interval between learning and testing increases. After a lapse of two or three weeks it is comparatively ineffective (33). It has been found that the effectiveness of review by

direct recall is similarly affected by the practice interval (9). Moreover, symbolical review, when practiced within two or three days after the learning exercise, is fully as effective as review by reimpression, more so if suitable objective tests are made the medium of such review. However, symbolical review, in comparison with the nonsymbolical, soon loses its effectiveness. After the lapse of two or three weeks symbolical review is distinctly inferior to review by reimpression.

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CHAPTER XI

LANGUAGE AND MEANING

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I. Introduction and Statement of the Problem

Lorimer introduces his discussion of symbolism and meaning, in his *Growth of Reason,* with the statement: "In entering upon the discussion of symbolism and meaning we are, as those who have followed recent philosophical and psychological literature are aware, headed straight for a fog-bank" (49, p.72). Ogden and Richards express a similarly pessimistic point of view when they point out that, although the term 'meaning' is ubiquitous in philosophical and psychological literature, its meaning is undefined, naive, or confused (68, chap. viii). The same criticism could be made of the literature of sociology and education, as well as that of linguistics where precision of usage might be expected to receive special emphasis. A given writer may use 'meaning' interchangeably with 'sense,' 'import,' 'signification,' 'interpretation,' 'semiosis,' 'symbolic process,' or 'awareness of relationships.' Moreover, an author may in some instances be so obsessed with one aspect of the problem as to make one of the most serious errors: the identification of the part with the whole.

The confusion which these and other writers bemoan is not surprising in view of the controversies which rage around many of the basic problems related to meaning and symbolism. Different schools of psychology attack these problems with diverse hypotheses and investigate them with very different methods. Philosophers, sociologists, and linguists are not less at odds. It is not possible here to list, much less to discuss, the various issues pertaining to meaning and symbolism; yet these issues are by no means academic, for any treatment of learning assumes some position with regard to each of them, no matter how naive or lacking in systematic formulation it may be.

Lorimer, after discussing the various senses in which symbolism and meaning are used, holds that it is important to distinguish between two radically different sets of references of the term 'meaning': "(1) *any relationship within the implicit processes of the correlation of behaviour (thinking)*, and (2) any organic or social *function of a symbol*," and urges that the latter usage be adopted in all scientific studies (49, pp. 87-88). Although the writer does not assume the necessity for so limiting the use of the term, it is with the symbolic processes that he is here concerned.

Within the broad area thus delimited, the present discussion will deal primarily with the attempts of students to make and express constructs through language. However, the writer does not mean to deny that the student is influenced by other signs, such as those sometimes referred to as natural signs, functioning with or without verbal associations. The illustrations which are utilized in the discussion are drawn chiefly from reading in relation to learning in the social studies, first, because of the considerable body of evidence which is available, and second, because these constructs illustrate so well the function, limitations, and social nature of language symbols. Many of the problems here dealt with are closely related to those treated by Brownell in his chapter on problem solving.

II. Sources of Theory and Evidence

The importance of the problems pertaining to meaning and language is attested by the fundamental place assigned to them by scholars in many different fields: different schools and specializations in psychology, logic and epistemology, linguistics, semantics, sociology, ethnology, cultural anthropology, and education. All of these fields contribute valuable theory and evidence pertaining to the making of constructs through language and their contributions should be fully utilized. This eclecticism is entirely justified even in a yearbook on learning, for each of these fields deals with some aspect of the learning *of* language and of learning *through* language. Writers in each of these fields draw freely from the literature of the others. Many of the men who have made the largest contribution to the solution of the problems of language and meaning, as, for example, Mead, Sapir, and Dewey, have been prominent in more than one field. Thorndike's *Human Nature and the Social Order* would be as properly classified under sociology as under psychology.

A. Contributions of Different Schools and Specializations in Psychology

The first section of this volume devotes a chapter to each of the principal schools of psychology. None of these chapters deals extensively with the problems of learning through language. Indeed, a very small amount of experimental research in any of these fields has been directly focused upon these problems, although it has produced valuable theory and evidence concerning such basic matters as sensation, perception, imagination, transfer, and motivation. In his summary of the theoretical chapters in Section I, McConnell points out that the schools of psychology have much more in common than their proponents assume. A similar conclusion is reached by Woodworth in his *Contemporary Schools of Psychology* (97). Each theory, however, may contain a useful emphasis. While in each case the so-called laws of learning have been developed from experiments in relatively simple learning situations, they may tentatively be assumed to hold, in so far as their validity is there established, for learning in more complicated situations (37, chaps. xi-xvi; 84; 99, pp. 746 ff.). Psychologists frequently warn, however, against applying laboratory results uncritically or too confidently to the formulation of methods of instruction.

Another yearbook could profitably be prepared dealing with the contributions to the problem of learning of various specializations in psychology, such as animal psychology, child psychology, social psychology, and clinical psychology. All these specializations provide important theory and evidence on meaning and symbolism.

Animal psychology, especially in its recent developments, raises some interesting questions regarding learning in situations involving natural rather than verbal signs (44; 64; 65; 88).

Child psychology has a rapidly growing literature devoted to the development and use of language by infants and young children, as well as to the nature and development of their concepts, their intelligence, and their ability to reason (5; 11; 17; 27; 40; 51; 55; 66, chap. xxii; 70; 71; 81; 93; 96).

Social psychologists as well as sociologists have been deeply concerned with the problem of language in relation to forms of culture, public opinion, and social control. Their emphases upon the social nature of language and its implicit function in culture, as well as

upon the significance of its social uses and abuses, are very important (1; 4; 14; 15; 22; 26; 49; 52; 53; 57; 58; 94).

Psychological clinicians and psychiatrists have put increasing emphasis upon language and meaning in their treatment of behavior problems and of various types of mental disorders (11; 12; 43; 45; 46).

B. Contributions from Anthropology, Semantics, Linguistics, and Philosophy

Anthropologists and ethnologists have shown that the language of primitive peoples is much richer and much more elaborate than it was formerly assumed to be and have emphasized the fact that the language of any people, primitive or modern, cannot be understood out of its cultural or behavioral context (7; 8; 29; 47; 50; 54). Linguists and general semanticists have made valuable contributions to the understanding of the origin, structure, and function of language, including both its uses and abuses (6; 10; 28; 41; 42; 45; 60; 78; 79; 91; 103).

The most critical and extensive treatment of meaning and symbolism is found in the recent literature of logic and epistemology (13; 18; 20; 23; 25; 36; 61; 63; 68; 74; 75; 90; 95). The contributions of the group calling themselves 'scientific empiricists' are particularly useful for the purposes of the present discussion. Morris, for example, points out that "the meaning of a term is completely specified when it is known what objects the term designates, what expectations it produces in the persons for whom it has meaning, and what its connections are with other terms in the language of which it is a part. The determination of the first gives the empirical dimension of meaning, the determination of the second gives the pragmatic dimension of meaning, and the determination of the third gives the formal dimension of meaning" (62, p. 13; see also 61).

The first dimension he calls the semantic; the second, the pragmatic; and the third, the syntactic. This statement, of course, presents his analysis in the barest outline, for the problems pertaining to each dimension are many and difficult, and the relation of each to the others is exceedingly complicated. The three dimensions are functionally interrelated and no one of them can be isolated except for purposes of theoretical consideration. Yet it is with the pragmatic dimension that instruction is most directly concerned.

C. Contributions from Education

The bulk of experimental evidence on language and meaning has come from educational research, which has dealt extensively both with the attainment of language abilities and with language as a medium of instruction. Research in reading has been particularly fruitful (30; 32; 33; 38, chaps. iv, v, and vi; 83). The data provided by this research have made possible substantial improvements in instruction; they also throw light on many fundamental problems in psychology, philosophy, and linguistics.

Available also is a large amount of data on the words most commonly needed in writing and reading as well as on the nature and extent of children's vocabularies at different grade levels (67). While investigations of vocabularies have dealt chiefly with word forms, attention is now being focused on word meanings (48).

III. Significant Trends in Theory

While, as has been previously pointed out, the basic theories pertaining to symbolism and meaning are still bitterly and extensively debated, there are a few significant trends in theory discernible throughout the literature of the various fields enumerated above. With the warning that these trends are just what the term 'trends' implies and that they are not equally prominent in the various fields, they may be stated as follows:

First, there is general recognition that language plays an important, if not a dominant, part in all human culture. In fact, as Sapir, suggests, "It is difficult to see adequately the functions of language, because it is so deeply rooted in the whole of human behavior that it may be suspected that there is little in the functional side of our conscious behavior in which language does not play its part" (79, p. 159).

Second, there is apparently a general rejection of the psychophysical dualism in which language is conceived as the external reflection of psychical processes. This theory is replaced by that which regards language as functioning in these processes. DeLaguna points out that "it is in the light of this function that the causes and course of its development must be sought. And it must equally be in the light of this function that an insight into its relation to conceptual thought is to be hoped for; nay more, that a new and deeper insight into the nature and place of conceptual thought itself may be attained" (18,

p. 19). Meaning and symbolizing are to be regarded, therefore, as two aspects of the same unified process.

Third, as implied in the preceding trend, the predominant function of verbal symbols in thinking is generally admitted. Some, indeed, go so far as to identify symbolization and thought, or at least to hold that the higher mental processes are impossible without language. "It is therefore indispensable for any high development of thought," says Dewey, "that there exist intentional signs. Language supplies the requirement" (21, p. 232; see also 19).

Fourth, the point of view from which the problems of language, meaning, and thought are being attacked is increasingly behavioristic, if 'behavioristic' is defined in the broad rather than in the restricted Watsonian sense. Language is associated with all consciously directed behavior, overt or otherwise. In such behavior it is a functional part of the objective situation which acts as a stimulus, as well as of the overt motor response. But it may also be a *substitute* for either the concrete stimulus situation or the overt response (94). Thus, as Esper explains: "Speech as stimulus may serve as a functional substitute for environmental situations; speech as response may serve as a functional substitute for overt behavior" (26, p. 420).

Fifth, the meaning of meaning is to be found not in a formal definition, but in the processes of meaning and in the various structures or dimensions observable in these processes.

Sixth, language and meanings are social in their origin, structure, and function. They are formed by social processes and in turn largely control the processes themselves. While there may of course be private aspects, language, meanings, and ideas are potentially intersubjective or social. This intersubjective quality provides the principal tests of their usefulness.

IV. The Making of Constructs through Language Stimulation

A. An Active and Complicated Process

The factors involved in making constructs from language stimuli may now be considered. The making of constructs, as the term implies, is an active process. Verbal statements, oral or printed, do not give the student ideas ready made and 'under seal'; they merely stimulate him to construct ideas for himself. When the statements deal with con-

structs which the student has already made, the process follows the general pattern of reproductive imagination. But in school most of the language that the student reads or hears deals with new meanings, new concepts, and new problems. In such instances constructive imagination is called into play. The attainment of a new idea is, from the student's point of view, a creative act requiring vigorous and efficient mental effort. But while, strictly speaking, there is no such thing as passive learning, a student's activity may be so feeble, his interest so weak or vacillating, or his thought so uncritical that the constructs he makes, if he makes any at all, are too vague and ill organized to be serviceable.

The processes of making constructs, moreover, are exceedingly complicated (84). Thorndike provides an illustration in the following paragraph:

> Understanding a paragraph is like solving a problem in mathematics. It consists in selecting the right elements of the situation and putting them together in the right relations, and also with the right amount of weight or influence or force for each. The mind is assailed as it were by every word in the paragraph. It must select, repress, soften, emphasize, correlate and organize, all under the influence of the right mental set or purpose or demand (87, p. 329).

This statement holds true whether the discourse be spoken or written.

B. An Analysis of the Factors Involved

The success with which a student makes a meaningful and valid construct in response to what he reads or hears is dependent upon three groups of factors: first, the difficulty and the complexity of the construct to be made; second, the adequacy of the language in which it is presented; and third, the student's 'funds'—his interest and mind set, experience, language abilities, and habits of work. That these three groups of factors are functionally interrelated in making a construct will be evident as each group of factors is dealt with in turn in the following discussion.[1]

[1] Tolman's analysis of the variables which determine purposeful behavior, while not specifically devoted to the making of constructs through language, may profitably be read in connection with the analysis here given. His emphasis upon processes is particularly useful (88, pp. 371-412).

1. The Nature of the Constructs To Be Made

Hull, in his chapter in this Yearbook, has shown that even the simplest forms of learning are much more complicated than they have been assumed to be. Their complexities seem insignificant, however, as compared with those involved in learning in such content fields as science, hygiene, geography, and history. It is strange that the inherent difficulty and remoteness of the problems in these fields has been so largely ignored. The significance of the number and difficulty of the problems in typical curricula is apparently not understood, or at least underestimated, by those directly responsible for making curricula, for formulating methods of instruction, or for providing suitable instructional equipment. Psychologists have given little attention to this complicated type of learning, and even the epistemologists and logicians, in their analyses of the problems of thought and meaning, have, for illustrative purposes, dealt with constructs incomparably simpler than those which the student is required to make in most books and courses of study in the natural or social sciences. Consider, for example, what is involved in making the following large constructs: the fall of the Roman Empire, the Darwinian theory of evolution, man's control of communicable diseases, free trade, the Industrial Revolution, the effect of sun position upon temperature, and the growth of democracy in the United States. No matter how high the student's intelligence, how adequate the facilities with which he works, how skilful the teacher may be, or how much time is available, such constructs are difficult to make. In fact, each one of them presupposes the making of many subordinate constructs, each of which is in itself difficult and complex.

The number of constructs, ranging from simple to complex and from easy to difficult, which a student is required to make at each grade level is absurdly large in view of the ability of the students and the time at their disposal. For example, Ritter found 2195 technical, difficult, and unusual terms in an introductory book in geography (73). Included in this number are 386 proper names, such as "Africa," "Antarctica," and "Appalachian Plateau," which are particularly difficult to interpret adequately in the contexts in which they are found. This book is commonly used in fourth grade. Pupils would be required to learn more than ten technical, difficult, or unusual terms each day. It is true that a few of the 2195 terms may have been pre-

viously learned, but on the other hand many of them are used in the book with more than one meaning. It must be kept in mind, moreover, that geography is only one of several curricular fields with which fourth-grade pupils are concerned.

Even if the constructs the pupil is expected to make were less difficult, the time available would be far less than he would require. The first step in establishing more favorable conditions for understanding is to drastically decrease, at each grade level, the number, difficulty, and remoteness of the problems which the pupils are required to attack.

2. The Nature and Limitations of Language

a. Its Prominence in Instruction. An analysis of the curriculum in any school will show that a large proportion of its topics or problems are remote from the immediate experience of children in that school. Most of the realities with which instruction deals, therefore, are not confronted directly, as in observing on a field trip that heavy rains erode the soil on tilled, hilly land, but through more or less adequate symbols of them, such as language, statistical tables, graphs, maps, and pictures. Surveys of classroom teaching have repeatedly shown that, as compared with other media of instruction, language plays the predominant role. Indeed, for many of the problems contained in typical curricula in science, geography, civics, and history, it is the only approach to knowledge that the schools provide. And even in schools in which visual aids, museums, field trips, and the like are most extensively used, a relatively small part of what is taught is or can be approached through these media. Most of the ideas that the student acquires in school are constructed from what he reads or hears. Moreover, in formal textbook-quiz procedures, which are all too common, the language upon which the student must depend generally falls far short of the potential contributions which language can make. Language also plays an important part in learning through other instructional media, even in the most direct objective experience.

b. The Symbolic Nature of Language. It is important, therefore, to understand the functioning of language in learning. Language is symbolic, with all the limitations and potentialities that the term 'symbolic' implies. Only rarely, and even then to a limited degree, as

in onomatopoetic words, is meaning suggested by the physical nature of symbols themselves. Consider, for example, the sentence, "At noon when the dust storm was at its worst the streets were dark as night." There is clearly nothing in common between the physical properties of the sentence and the events to which it refers.

Attention has already been called to the fact that in consciously directed behavior language not only functions as a part of the objective stimulus situation and the overt response, but may, sometimes properly, sometimes improperly, be substituted for either. Language can serve this dual substitute role efficiently only when the situation for which language is substituted is similar to, or has components of, situations actually experienced; when the response to which the language is substituted is a stimulus to, or has components of, one previously made; and when the previous situations and responses have embodied language as a part of the total process of stimulus-response. Any symbolization, no matter how abstract, should be connected with experience in a gapless chain, every link of which has had its meaning established by reference to experience. The utilization of language in this dual role of substitution *for* concrete situations and *for* overt responses is far too predominant in present-day instruction in comparison with the utilization of the language functioning *in* concrete stimulus situations and *in* overt responses. As a consequence, verbalism pervades instruction.

c. The Dimensions of Language. It may be profitable to look at language from the point of view of the relations involved in its use, since, as one psychologist has said, "In meaning, relationships are the one thing we have nothing else but." In discussing language, under the general theory of signs (semiotic), Morris emphasizes the importance of viewing it in its three essential aspects, symbolized in the formula $L = L_{Sem} + L_{Syn} + L_P$. In this formula, corresponding to that given for the dimensions of meaning, L_{Sem} refers to the semantic dimension, the relation of the sign to the object with which it deals; L_{Syn} to the syntactic dimension, the relation of words to each other; and L_P to the pragmatic dimension, the uses of signs by the sayer and the sayee. These three dimensions are, of course, but three aspects of one and the same process (61, p. 10 ff.). The efficient functioning of language requires that each dimension operate under definite rules: semantic rules determine how words should be related to the objects

they symbolize; syntactic rules determine how words should be used together; and pragmatic rules govern the relations of the words to those who use them. There is, however, as Morris points out, a pragmatic element in all these rules.

(1) *The semantic dimension.* Consider first the semantic dimension.[1] Language, even at its best, does not 'mirror' objective reality; it symbolizes certain aspects of it and, except for generic aspects, it does this imperfectly by selection, emphasis, and abstraction. Thus, anything that is written or said about a dust storm is very much less than the dust storm itself. It is of course, never the experience of the dust storm itself but always a very abstractive, conceptual reference with many potentialities of concretive implications. Nevertheless, a person who experiences a dust storm can neither understand it nor adjust his behavior to it appropriately without language.

The writer who has experienced a dust storm may find it difficult to write an account of it in his diary that will adequately serve to assist him, at some future time, in making an adequate recall of his experience. He will find it much more difficult to write an account that will convey to another person, particularly the immature and inexperienced reader, an idea of what a dust storm is really like. In fact, the word 'convey' is somewhat misleading, for the best that the writer can do is to use words which will stimulate the reader, within the limits of his experience and abilities, to construct the idea for himself.

Every statement made about a dust storm symbolizes some aspect selected as important, importance being measured both by the interest and purposes of the sayer and by the interest and purposes of the sayee. Thus, what a geologist would write about a dust storm for a scientific journal would be different from what a casual observer would write to a friend.

The fundamental requirement of all language symbols in terms of the semantic dimension is that they arouse approximately the same expectation in those who use them (43, pp. 1-36). It is this public or social aspect of language, as contrasted with the private, that Dewey and Mead have strongly emphasized (22; 57). The discussion and illustrations which follow will make it clear that school conditions

[1] The term 'semantic' is sometimes used more broadly, to apply to the entire process, rather than to one dimension alone (92a).

are none too favorable for enabling the student to meet this social requirement.

(2) *The syntactic dimension.* Since language is a system of interconnected signs, it is essential that the student understand the nature and significance of this interconnectedness. It is obvious that the meaning of individual words is dependent upon their syntactic context, and that failure to observe syntactic rules may lead to error. The term 'context' is often used in educational discussion to refer to the fact that the meaning of a word is determined by its use in a sentence. But even syntactic context goes beyond the sentence, for the understanding of a word in a sentence, as well as the sentence itself, may necessitate the understanding of the paragraph in which the sentence is found, or possibly even the understanding of the chapter or the book. In formal logic, for the purpose of studying the syntactical quality of language, context has been purposely narrowed to the interconnectedness of signs (13). But it is with larger context that the educator is primarily concerned, and so for him context includes also the semantic and pragmatic dimensions. More attention to the significance of context would do much to offset verbalism and to prevent the inadequate and erroneous ideas which students so frequently form (92a, chaps. v-vi). Context has been much stressed by field psychology, yet its importance is also clearly recognized in connectionism and in behaviorism.

Thanks to logicians and linguists, the analysis of formal or syntactic dimensions of meaning and language is much more complete than is the analysis of either the semantic or pragmatic dimension (61, pp. 13-20). The substantial contribution that logic and grammar have made to the theory of meaning as an epistemological problem suggests that it may make a fundamental contribution also to the problem of meaning in instruction. It is possible that the study of grammar may have values that warrant its resumption in instruction, providing the formalism into which it formerly degenerated can be avoided.

(3) *The pragmatic dimension.* The pragmatic dimension includes the relation of language to the purposes of the sayer and the sayee. Increasing importance is being attached to these relationships in all of the fields which have been shown above to be interested in the problems of language and meaning. In reading, as well as in objective experiences, selection, organization, and interpretation are all governed

by purpose. It is purpose that guides the construction of ideas and holds them together. Pragmatically considered, such terms as meaning, significance, and value, all imply the question, "For whom?" It is to be expected, therefore, that purpose should also govern the use of language to symbolize the idea.

This brief statement of pragmatic relations seems to be quite in harmony with the importance attached to purposes and goal-seeking in behaviorism and in purposivism or Hormic psychology (52; 53; 88; 97, chaps. iii and vi). Up to the present time, however, the representatives of these schools have been chiefly concerned with learning situations much simpler than those involved in the building of complicated constructs through language.

d. The Uses and Abuses of Language. It is impossible here to enter into a detailed discussion of the functions of language in thinking, in overt behavior, or in complicated forms of social control. Progress in civilization has been attributed to its proper use, and most of the evils and maladjustments, to its improper use. From one point of view language is less than the object it symbolizes; i. e., it cannot be examined and manipulated in the same way as the object; but from another point of view it is more; i. e., it makes possible uses, transformations, and organizations which would be impossible without it. The power of words to select, abstract, emphasize, generalize, or interpret from particular instances and to refer to things nonexistent or hypothetical, or to things which vary from a particular instance in one or more ways, is the source of invention, problem solving, and artistic creativeness. It is also the source of misconceptions and maladjustments (43; 45; 46). The benefits which it gives can be obtained and its ill effects avoided only by a clear recognition of such limitations as have been pointed out above.

We here are concerned, however, with the uses and limitations of language in instruction. Perhaps there is no better example of the disregard for the limitations of language than is to be found in typical textbook instruction. Not only does the course of study contain numerous and difficult ideas, but these ideas in most schools are presented to students chiefly, if not solely, in a single textbook which, because of the limitations of space, treats each idea in general, abstract, and often ambiguous language. The generalized statements which the books provide may symbolize general ideas for the author and perhaps to the mature reader to whom the ideas are already

familiar, but the statements have no such meaning for the student. He has not yet constructed these ideas. He is expected to do so from reading his text. Yet the detailed data for making these constructs are not provided in the books; nor can it be assumed, in most instances, that these data are known to the student.

Moreover, it is not merely the vague and abstract character of the textbook that is at fault. A single textbook is commonly provided for a grade, in spite of the incontestable evidence of the wide range of knowledge and ability in that grade. The range in reading ability, expressed in grade norms, is almost invariably at least five years, and often seven. Investigations have repeatedly pointed out that the typical textbook, even within the limits of its potential usefulness, is much too difficult for the median child in the grade for which it is designed, and it is hopelessly difficult for the children in the lowest quarter in reading ability.

The situation is not much better in most schools that make some attempt to supplement the single text by collateral readings, first, because the collateral readings, frequently none but other textbooks, are usually little less vague and general than the text itself, and second, because the range in the reading difficulty of the books provided is not commensurate with the range in the reading ability of the class. A very considerable proportion of students are required, year after year, from elementary school through college, to read books that are quite beyond their comprehension. It is not surprising that the ideas which these students get from reading, in so far as they get any, are unsatisfactory or that so many students become impressed with the futility of attempting to learn from books. Until these deplorable conditions are removed, even the best teachers are hamstrung in their attempts to develop understanding through reading. Fortunately, we know how to set up more favorable conditions for learning (38, chaps. v-x).

In view of the known limitations of language, it is unfortunate that its use should be so overwhelmingly predominant, if not actually exclusive, as a medium of instruction in comparison with other media, such as field trips, constructive activities, and various forms of visual aids. From the first years in kindergarten and first grade, pupils are challenged to formulate ideas through the medium of language alone and from very inadequate experiential backgrounds. In each succeeding year new ideas are fabricated from the vague and inaccurate ideas of the year before. This unsatisfactory procedure could be greatly

remedied by supplementing language with other and more concrete media of instruction, and by encouraging students to make full use of whatever backgrounds of experience they have acquired outside of school. For example, the student who has neither performed the process of weaving, nor seen it performed, has difficulty in understanding it from verbal description. But if he has performed the process even on a simple loom, he is greatly assisted in understanding the fundamentals of the process in its more complicated forms. Language appropriate to the process and the understanding of the process develop together.

Yet in pointing out the limitations of language in instruction, one should not disparage its importance. Language, when adapted to the needs and limitations of students, is an important source of knowledge, even when used alone. And even the most concrete forms of instruction, such as the field trip and the constructive activity, are guided and made meaningful through the use of language. Therefore, the importance of a command of language, including reading ability, can scarcely be overemphasized. It is not its use but its abuse that should be eliminated. The effective use of language should constitute one of the principal objectives of instruction. Far more care than at present must be exercised in making its use more precise. Improvements will come in this respect, however, not so much from formal exercises as from the constant use of language in relation to the experiences and purposes which give it meaning.

3. Limitations Inherent in the Student

The number and difficulty of the concepts which confront the student in typical schools and the limitations of the language through which these concepts are presented become even more significant when these important factors are considered in relation to the limitations and potentialities of the students themselves. The preceding discussion has emphasized two facts: first, that the student cannot be given meanings, but can only be stimulated and guided in constructing them for himself; second, that how satisfactorily he does this depends upon his 'funds,' the most influential of which are his experience, his interest, his intelligence, his command of language skill, and the vigor, persistence, and efficiency of his methods of work. The importance of these 'funds' warrants a more systematic and detailed treatment.

a. The Student's Knowledge and Experience. Among the factors which determine the adequacy of the constructs which students make, experience is perhaps the most influential. It is to be regretted that, in the reaction to the formalism into which Herbartianism often degenerated, the fundamental truth of the theory of apperception has been lost sight of. Constructs must be made by the student out of the materials of his experience. Yet many of the ideas included in the course of study, especially in fields like history and geography, are far removed from the experience of students at the grade level where these ideas are presented. What sort of constructs, for example, can most fifth-grade children be expected to make from the following statement, taken from a fifth-grade textbook? "Iron ore is obtained from Red Mountain near Birmingham, Alabama. Try to imagine standing on this mountain in the evening watching the city brighten with the red glare from the *huge* furnaces in which ore taken from the very hill on which you stand is being made into steel." The pupils of one fifth-grade class who read this paragraph showed very little comprehension of the term 'huge' as applied to furnaces of the type here meant. Among the responses obtained from individual case studies were: "a little higher than our furnace," "about as high as the doorway," "It is large as New York," "maybe as big as that" (pointing to a filing case), "three feet tall," "higher than a table," "about as tall as this building" (77). Why should we expect children to know how huge are the 'huge furnaces' referred to in this paragraph? Other words and collocations in the statement, such as 'iron ore,' 'mountain,' 'made into steel,' are, without supporting detail, difficult to interpret from the experiences of most fifth-grade pupils. They are not much helped, therefore, by the context in which 'huge' is found. A large proportion of the statements found in books in common use in schools pertain to concepts even farther removed from the students' experience than is this one.

Eaton points out that, "Knowledge as a whole falls into two great divisions: mediate and immediate, knowledge *about* and *acquaintance with* objects. The former rests on symbols alone; the latter is a union of symbolic knowledge and direct apprehension" (25, p. 38). In the examples cited above, there is little probability of the pupils of many communities having 'acquaintance with' the manufacture of steel or much 'knowledge about' it. They may, however, have other 'acquaintance with' or 'knowledge about' steel, manufacturing cities, mountains, and the like, which, if called into play, would enable them to make

much more usable constructs than those manifested by these particular children. Such knowledge should, of course, be fully utilized.

Unfortunately much of the pupil's background for making the constructs required of him in school is a mere accumulation of casual experience and uncritical discussion, and as a consequence is likely to be vague, inaccurate, and haphazard. To be serviceable in making new constructs it needs to be clarified, corrected, and organized. The quality of the constructs which a pupil makes is determined by the quality of the constructs which he has already made. Too much stress, therefore, can hardly be placed on the importance of clear, accurate, and well-organized ideas, constructed directly from experience, as the basis for achieving other ideas.

b. Interest and Meaning. Most, if not all, of the motives which operate in school instruction have been learned. In other words, interest, motive, and purpose grow out of experience as much as does cognition (100). It is generally recognized that established habits can energize and direct behavior as well as confirm or reject reactions. We are here primarily concerned, however, with the making of constructs under the guidance of clearly conceived purposes. In such instances understanding and interest are reciprocal in their relationships. As already implied in the discussion of the pragmatic dimension of meaning and language, purpose directs the making of mental constructs, determines their organization, and keeps them responsive to life. Interest in a construct is progressively increased as understanding is deepened and enriched. For a topic to be uninteresting is therefore a serious matter. Yet many of the topics or problems in typical curricula seem to the student to have little or no pertinence either to his needs or interests or to the needs and interests of other people that he knows.

McConnell, in his chapter, "Reconciliation of Learning Theories," states the function of motivation to be as follows: "Motives initiate and energize activity, direct the organism's behavior, and dispose it to select some responses and disregard or eliminate others." His review of the ways different theories of learning interpret the facts involved in the operation of these functions makes it unnecessary to do so here, except to point out that there are many troublesome problems, such as the classification of motives, their complexity, their integration, the degree to which they are explained by original nature or by environment, their operation in incidental learning, and the function of

symbols in motivation which either are not dealt with or are touched upon lightly in these theoretical chapters (2; 85; 88; 100; 101). It may be worth while, however, to call attention to what seem to be some very important consequences of viewing motivation as a purposeful direction of behavior toward a goal (52; 53; 59; 88; 98; 100).

It is customary to make a distinction between primary motives, such as hunger, and secondary or extrinsic motives, such as punishment, rewards, or competition (88; 101). Most experiments in motivation with human subjects have dealt with secondary motives. Little attention has been given to the effect upon learning of such motives as arise out of the recognition and appreciation of the intrinsic life function of the material to be learned (85, pp. 108-34). For example, there have been few experiments in the operation of such specific purposes as how to cure a cold, how to prevent poisoning from poison ivy, or what to eat in order to have good teeth. It seems reasonable to assume that it makes a good deal of difference what sort of goals the student seeks. As Gates points out in his chapter in this volume, "The effectiveness of an outcome in enlisting a confirming reaction depends upon the degree of its relevance to the individual's purpose and the closeness with which the outcome is felt to 'belong' to a particular behavior." Learning appears to be most effective when the goals are set up in terms of the intrinsic life function of the material to be learned.

When such intrinsic motivation is lacking, recourse must be taken to extrinsic motivation, such as rewards and punishment, praise and reproof, grades, and competition. These extrinsic motives appear to be inferior to intrinsic motives in the degree that they energize the making of constructs, especially where prolonged effort is required, and they are certainly markedly inferior in their usefulness as norms for guiding the selection and evaluation of data, the organization of these data into usable form, or for the critical appraisal of the outcome. Moreover, when achievement is defined in terms of one or more extrinsic motives, such as better grades, what achievement should mean in terms of the intrinsic function of the material to be learned is obscured.

Since it is the use to be made of an idea which holds it together and keeps it growing, intrinsic motivation appears to be basic in the problem of meaning. The acceptance of this principle does not require the elimination of extrinsic motives, but it does imply that they should be used to reinforce intrinsic motives rather than to supplant

them. Some intrinsic motives seem to be more easily adapted to such reinforcement than are others. For example, stick-to-it-iveness, pride in doing a good job, and awareness of success seem to be less arbitrary and extraneous than grades, artificial rewards, or punishment.

In closing this brief discussion of the interrelationship between interest and meaning, it may be well to point out that language symbols are predominant in the initiation, energizing, directing, and confirming of mental constructs. Moreover, emotionally tinged language is apparently a very influential type of conditioning.

c. Intelligence. There are important differences among the definitions of intelligence and in the methods and hypotheses with which investigators approach the various problems related to it (9). But no matter which definition of intelligence one accepts, it is clear that intelligence so defined, even though it may not yet be adequately measured, must play an important part in the attainment of meaning. This is true regardless of whether intelligence be thought of as unified or manifold and regardless of the factors or categories into which its structure is analyzed. In reading the literature pertaining to intelligence, one is impressed by the frequently recurrent use of such terms as generalization, the ability to see relationships, abstract thinking, the ability to make inductions and deductions, verbal ability, inventiveness, and adequate response or adjustment to new problems or situations. All of these factors are involved in the making of mental constructs.

Special attention should be called to the interrelations of language and intelligence. The predominance of verbal symbols in thinking is generally admitted. Indeed, as previously pointed out, some writers go so far as to identify symbolization and thought; others hold that the higher and more complex mental activities are impossible without language. It is not strange, therefore, that the language part of an intelligence test should strongly influence the total score on the test. In fact, language is deeply involved in most if not all of the factors into which intelligence has been analyzed.

It seems clear that relatively high mental age is required to deal adequately with the many difficult and complex ideas presented in typical curricula. There is a growing body of evidence that indicates that a large proportion of the problems which confront pupils at various grade levels require a higher mental age to solve, except through inordinate effort, than the average pupil in those grades possesses

(31). The more difficult ideas are attained even by the gifted pupil with great effort, and the lower fourth of the pupils are seriously frustrated in their attempts at understanding.

The influence of intelligence, however, as measured by any given test, can easily be overestimated. For while the reported correlations between intelligence scores and achievement are positive, they are not high, even in curricular areas where intelligence presumably must play an important part. A number of investigators have presented theory and evidence which suggests that other factors, such as interest, emotion, experience, industry, and systematic training, are much more influential, as compared with intelligence, than has commonly been assumed (9; 56; 72; 89).

In the light of our present knowledge of the relation of intelligence to achievement, it would be rash to estimate the limits of intelligence below which the understanding of any given problem is frustrated. Understanding is a matter of degree, and every student may reasonably be expected to achieve some grasp of any problem pertinent to the common needs and activities in his community. There is an abundance of evidence, however, which shows that under conditions commonly found in schools, students of the lower levels of intelligence develop very inadequate understanding of many of the more complex problems which confront them.

d. Command of Language Abilities. Language abilities constitute the most important group of abilities that the school seeks to develop. Shortcomings in language are certain to hamper or even frustrate achievement of all sorts, and especially the achievement of meaning, for, as has already been pointed out, language is not merely the chief medium of instruction, but is also an indispensable instrument of thought.

In fact, language is not a distinct or unique factor separate from others which influence the attainment of meaning; it pervades all other factors. For example, it makes possible the acquiring, recall, and growth of experience, it permeates intelligence, and it is a requisite vehicle in all methods of teaching and study. Perhaps it is too often thought of merely as a cause of inadequate learning, for it is an effect as well. Low achievement in reading, in listening, and in oral or written composition is prima facie evidence of poor learning in other curricular fields. For learning in these fields is impossible without

language abilities, and if learning in these other fields is efficient, reading and other language abilities will be developed to a degree not possible in formal language instruction. This statement does not imply, however, that there is no place in the program of studies for instruction which focuses primarily upon the improvement of language abilities. Systematic instruction in language facilitates its use in other curricular areas and enables the student to make the most of the contributions of those areas to the development of greater proficiency in language itself (38, pp. 200-205; 39).

It is important to keep clearly in mind that the relation of meaning to language is the same whether the symbols be spoken or printed. Investigations have shown that at higher grade levels students who cannot understand what they read usually cannot understand what they hear (76; 102). Young, for example, reports correlations averaging above .80 between the ability of students to understand a passage they have read and their ability to understand the same passage when it has been read to them. That there is an intimate relationship between the scores made on visual and on auditory forms of presentation is shown even more clearly in Young's quartile comparisons than in his relatively high correlation. For example, in one of his experiments involving 104 subjects, of the 26 pupils who constituted the highest fourth in the ability to understand what was heard, 20 were in the highest quartile in the ability to understand what they read, 5 in the second quartile, 1 in the third quartile, and none in the lowest quartile. Other studies in learning, including retention, in which learning through reading has been compared with learning through hearing, have produced closely comparable results (82).

Such data seem to show that, with the exception of a few special types, most of the so-called disabilities in reading, in the students' own verbal expression, and in hearing may be more properly ascribed to basic disabilities in language symbolization. The fundamental implications of this fact for instruction in reading and language have often been ignored, and as a consequence more technical and peripheral aspects, such as phonics and eye movements in reading and mechanical drills in the formal aspects of written and spoken language, have been greatly overstressed, both in practice and in investigations, to the neglect of the vastly more important functions of language in relation to the central thought processes (35; 38, chap. v; 102, pp. 250-52). Certainly, in the attainment of meaning, it is the nature, function, and

limitations of verbal symbols in the three dimensions previously described which must receive the chief attention.

This close correspondence between comprehension in oral presentation and that in visual presentation may have other implications. Linguists have emphasized the fact that spoken language is primary and printed language secondary; i.e., printed words are only the symbols of symbols. "A written word," says Jespersen, "is mummified until someone imparts life to it by transposing it mentally into the corresponding spoken word" (42, p. 18). If, as Jespersen holds, written language is dependent upon spoken language, this fact may be very significant. For not only are the topics about which the student reads in school not commonly discussed among his associates, but the language in which these topics are presented in his textbooks is, to a marked degree, different, in its vocabulary, its sentence pattern, and its abstractness, from that which he is accustomed to speak or hear. He may therefore find the textbook language awkward to use in constructing the ideas which it is meant to symbolize.

There has been considerable interest, in recent years, in attempts to remove comprehension difficulties through the simplification of vocabulary (16; 34; 38, pp. 156-71; 69; 86; 92; 92a, ch. ix). Too much should not be expected from these attempts. It is, of course, a matter of common sense to use words known to the students whenever these words express the meaning satisfactorily, but the simplification of vocabulary alone is palliative, at best. It does not strike at the heart of the problem, for it does not alter the fundamental frustrations caused by the difficulty of the concepts, their lack of pertinence to the experience of the reader, or the lack of color and detail in the language through which they are presented.

Even the small potential benefits that may come from vocabulary simplification are not likely to result from mechanical tinkering according to set formulae, especially when the data for the formulae are based upon data on word forms. It must be kept in mind that the same word form may symbolize a variety of meanings, some of which may be known and some unknown to the reader. 'Run,' for example, is in the second hundred of the Thorndike list, but it has very different meanings in the following contexts: The disease has *run* its course. The fence *runs* east and west. To *run* to seed. To *run* a garage. To *run* a splinter in a finger. To *run* out of money. To *run* to ruin. To *run* a risk. To *run* up a bill. To *run* across a friend. To knock a home

run. A *run* on a bank. The common *run* of persons. The important thing to be considered is not whether the word form appears in a given vocabulary list—even a list of word forms assumed to be known to children—but rather whether the reader can be expected to identify the particular meaning of the word in the context in which it is used. All that has been previously said about the interrelationships between language and meaning suggests, first, that they develop together, and second, that the words used in expressing any concept should be adequate for that purpose. A complex concept requires complex language.

There have been a few investigations of the effect of simplifying vocabulary upon comprehension (38, pp. 158-72). These investigations leave some doubt as to the extent to which a selection can be made easier to read by the simplification of vocabulary alone. As a matter of fact, simplification of vocabulary cannot go very far without involving other factors, such as sentence structure and some modification of the intended meaning. It would seem reasonable to suppose, however, that unknown words should not be used to express an idea when known words will express the exact meaning. There is some evidence to justify the common-sense belief that the skilful and judicious simplification of all structural elements, such as vocabulary and sentence form, makes meaning more easy to achieve. The more critically these elements are analyzed, however, the clearer it becomes that their significance lies not so much in their intrinsic importance as in their reflection of more fundamental factors related to them. For example, a difficult vocabulary is related to the difficulty of concepts and their remoteness from the student's experience, and the use of a large number of difficult or even technical words is related to the complexity of the ideas with which they deal.

There seems to be a close correspondence between the adequacy of a student's verbal statement of an idea and the clearness with which he grasps the idea. Nor is the function of verbal statements limited to their use as a test; they play an important part in the process by which the idea is constructed. The verbal statement of goals and processes increases efficiency in simple forms of learning, such as handwriting. It seems reasonable to assume that the more difficult the idea to be attained the more important the student's verbal statement becomes.

The possible usefulness of the verbal memorizing of language, either that which is not understood or which at the time is understood only

partially or vaguely, deserves careful study. The functional relations of the three dimensions of meaning and of language have already been pointed out. The understanding of a statement in all of these relationships takes time and effort. It is conceivable that it is occasionally necessary or at least desirable to memorize a fundamental statement, even though it be inadequately understood at the time, in order to hold it before the mind while its various meaning relationships can be more fully ascertained.

e. The Student's Methods of Work. The preceding discussion has emphasized the active process of constructing ideas and has shown the dependence of the process upon the student's knowledge and experience, his language abilities, his interests, and his intelligence. Serious inadequacies in any one of these factors may frustrate the process. But even when all of these 'funds' are reasonably adequate for the problem at hand, their potential contributions may be thwarted by inadequacies in the student's methods of work. The construction of an idea requires thinking, and the more complex the idea the more critical and prolonged the thinking must be (38, pp. 104-13; 151-205).

The significance of the processes of thought in relation to its products deserves a special emphasis. The construct that the student makes is permeated with the processes through which it was formed, and it is not merely inert vestiges of the processes that remain; they are forces that determine the degree to which the construct is kept dynamic, growing, and usable. Inadequate and erroneous ideas reflect the improper methods by which they have been attained. In dealing with such ideas, therefore, the fundamental procedure is to inquire into the processes by which they have been constructed. It may be that some of the student's 'funds' were inadequate or that they were not used to their full potentialities, but whatever defect in the process is found, it must be corrected. Otherwise it will continue to operate to perpetuate blunders and shortcomings.

How much time is required to construct a usable idea will depend upon the factors which have been described above, such as the complexity of the idea, the language in which it is presented, and the student's 'funds.' One of the first results of the attempts to apply the Herbartian theory of apperception to learning was the realization that there was not enough time to form the many ideas in the overcrowded curriculum. Much more time than is generally available is required for a minimum initial understanding of even the simplest con-

cepts in the various curricular fields, and to this time must be added that required for maintenance and growth. And it is not merely time which is required, but persistent and intelligent effort as well.

C. The Influence of These Factors upon Understanding

1. Individual Differences in Responses

The interrelated factors discussed above, and others, such as those listed by Tolman (88), are combined among *N* pupils in *N* patterns, each different in some respect from the others and in many instances crucially different. It is clear, therefore, that in terms of the sayee the author or speaker does not say the same thing to each student in a class of forty; rather, he says many things. To some whose 'funds' are exceedingly limited he may not say anything; to a few he may say approximately what he means.

It is a well-known fact that a stimulus word in a free association test may, and usually does, evoke many different associated responses (43; 99, pp. 746 ff.). The significance of this phenomenon has not always been appreciated (43). It is to be expected that the responses to a sentence or paragraph, or to a word in context, should be somewhat more restricted; yet even in these instances a great variety of responses has been repeatedly shown.

Thorndike was among the first to report varied responses in reading and to call attention to their implications (87). A large number of other investigators have subsequently reported the varied responses which students make in reading selections from their textbooks. True-false and multiple-choice tests necessarily limit the number of different responses, but wherever free responses are stimulated, a great divergency of responses is usually found.

For example, in an experiment by Short, twenty-seven seventh-grade pupils were asked to read the sentence: "There were few newspapers in these early days of which we have been reading (about 1775); mail was slow and very irregular; and railroads and telegrams undreamed of." When asked, "What do you understand is meant by the statement that the mail was 'very irregular'?" the responses were: "Sometimes it went and sometimes not, sometimes it never got there" (1); "Sometimes it probably came a week apart, sometimes more" (2); "It didn't always get there" (3); "Trains would get broken down" (4); "They didn't know when it would get there" (5); "It does not come all the time" (6, 20); "When it snowed it was stopped until the snow

melted" (7); "It didn't come regular every day even if it was written" (8); "It went in a straight line" (9); "It wasn't picked up at a regular time" (10); "Sometimes fast and sometimes slow" (11); "Not sure of getting it" (12); "They had no set schedules" (13); "Uncertain of whether you were going to get it or not" (14); "They didn't know whether it would come or not" (15); "Half the time the mail would come about a week slow" (16); "Came at different times" (17); "It means rough or zig-zag" (18); "The mail zig-zagged all over" (19); "It was slow" (21, 26, 27); "No regular route" (22); "Came at no certain time" (23); "It didn't mean a thing" (corroborated in conference) (24); "Not on time or anything like that" (25). The numbers inserted after each response indicate the rank of the student or students in reading ability (80).

2. Classification of Responses

The responses of the student to typical selections that he reads in various curricular fields may be classified into four types: First, he manifests some comprehension, varying from much to little, of a small proportion of the ideas that the selection contains. Many of the ideas that he forms, however, are too vague and incomplete to be of much use to him. Vagueness, which Dewey has referred to as "the aboriginal logical sin," is very common and is difficult to combat (21, p. 160). Second, he may respond by giving statements read, either verbatim or in slightly paraphrased form, with little or no understanding of their significance. This response is a frequent refuge of the conscientious pupil who, motivated by school marks, desire for approval, or desire for some sign of accomplishment, is frustrated in his attempts to understand the selection. Third, he may make no overt response whatever, either right or wrong, or may say, "I don't know." This may be designated as the 'nobody-home' type of response. The ideas presented are simply 'un-understood.' Fourth, he may make constructs that are partially or wholly erroneous. When the selection read deals with new and difficult ideas, this type of response is very common. The number of reasonably adequate responses in a given instance depends upon the many interrelated factors which have previously been discussed. Investigations of comprehension in reading have included selections of a wide range of length and difficulty. The average percentages of correct responses reported in these investigations are, in most instances, well below fifty (38, pp. 180-87).

3. Additional Examples of Unsatisfactory Responses to Selections Read

Erroneous constructs warrant special attention, since they not only illustrate the inadequacies in the constructs which are made but also often point to the difficulties which children confront in their effort to understand what they read or hear. A few examples in addition to those previously given are therefore presented here.

The reports of investigations of comprehension in reading contain great numbers of examples of erroneous constructs. One of the most extensive of these investigations is that by Joseph C. Dewey (24). Among the selections read by eighth-grade pupils in his investigation was the following: "Since there were no matches in 1763, the most primitive way of starting a fire had to be used. A piece of very hard stone called flint was struck against a bit of steel. This produced a spark, which was caught in tinder or in soft, dry cloth." Among the verbal responses given to questions concerning the meaning of 'primitive' were these: "the only way," "the easiest way," "the most important way," "the best way they could think of," "the most used method," "the usual way," "the most dangerous way," and "a new way."

In addition to pencil-and-paper tests and to oral interviews, Dewey also tested understanding by the use of pictures and objects. When the pupils were shown four pictures representing this and other early methods of fire making and were asked to choose the picture representing the method described in the selection, many were unable to do so. And when, in personal interview, they were confronted with a variety of objects, including those mentioned in the selection, some students could not select the necessary implements; and when flint, steel, and tinder were provided, some could not show either how to produce a spark by striking the steel against the flint or how to utilize tinder to make the fire. The commonest erroneous overt response was to rub objects together, suggesting the prepotence of friction as a cause of heat.

An investigation of the ability of fifth-grade pupils to read paragraphs selected from fifth-grade textbooks, reported by Ayer (3), shows the difficulties which confront pupils in reading figurative language:

"Daniel Webster said of Hamilton, 'He smote the rock of national

resources, and abundant streams of revenue burst forth. He touched the dead corpse of public credit and it sprang upon its feet.' "

Among the responses to free-expression tests on this selection were these:

"Daniel Webster said that Hamilton a plenty of Government has burst forward. He put his hand on the dead people and free to everybody and it grew to its feet."

"When he touched the dead they would spring to their feet."

"Daniel Webster said of Hamilton, 'He stopped mother nature and fake rivers came instead. He stopped public credit and it was returned to him.' "

"Hamilton tried to break up the nation."

It is not alone to the figurative language, however, that these 'howlers' are to be attributed; the idea itself is exceedingly complicated, and no brief statement, no matter how simply written, will enable the student to make an adequate construct of the nature and effects of Hamilton's financial policy, unless he has previously learned a great deal about it. The use of metaphoric language is, of course, an added difficulty.

In some instances no student in a class may be able to understand a given passage which is read. For example, Short (80) investigated the meanings that each of a class of twenty seventh-grade pupils constructed in reading selections from their text in American history. Among the sentences utilized was this: "The Missouri Compromise of 1820 established the parallel of thirty-six thirty between slave and free territory." The question, "What is meant by the parallel of thirty-six thirty?" elicited no satisfactory answer. The students' answers are given below, the number after each response indicating the rank of the pupils in reading, as measured by the Stanford Achievement Test: "That the slave and free states were evenly populated and were the same in strength" (1); "Boundary line between slave and free states was 36° north latitude and 30° north latitude" (2) and (17); "Latitude" (3) and (7); "The latitude and place" (4); "The two lines of the year thirty-six" (5); "The line drawn between the slave and free states" (6); "Well, they kept it even—the same amount of territory for slave and free" (8); "Degrees" (9); "It means a certain place on the globe which is 36° west longitude, 30° north latitude," (10); "Means half and half between slave and free territory" (11); "The year of 1836" (12); "Around 36 and 30" (13); "The year 336" (14); "The slave

and free territories were equal" (15); "I think the parallel of thirty-six thirty means half and half" (16); "It was on the 36th year and on the 30th day" (18); "Even numbers" (19); "Even" (20); "I don't know" (in conference the pupil said something about lines on a map) (21); "They were half and half" (22); "The north had so much and so did the south" (23); "That's when they—Mr. Lincoln and Congress—made the parallel line on the map—all of them sat around a big table and Mr. Lincoln drew the line and read the Emancipation Proclamation" (24); "About this many slaves in all north, south, and west and east" (25); "It means they established (put in homes) that many people" (26); "I haven't the slightest idea" (27).

The examples which have been given above were intentionally chosen to illustrate types of erroneous responses. Although these examples can be matched, both in variety and in the proportion of erroneous responses, by many others reported in investigations in reading, the conclusion should not be drawn that comprehension in reading is always so unsatisfactory. That erroneous responses are very common, however, is clearly indicated in many published investigations.

4. Inadequate and Erroneous Responses as a Result of Unsatisfactory Conditions for Learning

Language, as used in the ordinary circumstances of life, offers no such difficulties as are displayed in the illustrations given above. Suppose, for example, that one afternoon Bill and John are planning a fishing trip for the next morning. John says, "I'll get the worms. There are lots of them in our garden."

"All right," replies Bill. "You get the worms and I'll make some sandwiches."

Neither boy would have any difficulty in knowing what the other intended to do. The constructs are simple, demanding only slight reorganization of previous experience; and the meaning of the language is clear in the context in which it is used. The whole projected enterprise is closely related to the boys' interests and purposes.

None of these favorable conditions exists in the reading of typical textbook statements. The constructs to be made are difficult and complex. The detailed knowledge required for the construct is not given in the text, and in most instances cannot be assumed to have been previously acquired. The language itself is often difficult, both in vocabulary and sentence structure. Often the words are, to the stu-

dent, merely the forms of symbols; they do not symbolize. The making of the construct has no such direct motivation as is provided in the plan for a fishing trip. The pupils' own resources and limitations are given scant consideration.

A critical and realistic consideration of these unfavorable conditions makes it apparent that the inadequate and erroneous conceptions formed by pupils in various curricular fields, far from being something to wonder at, are precisely what one should expect. For while, of course, instruction is not deliberately planned to foster the development of inadequate and erroneous ideas, it is, nevertheless, organized in such a way that these results are sure to follow. Erroneous constructs which the pupil makes from reading or listening are made in the same way in which adequate constructs are made; that is, under the stimulation of the author's words and through the exercise of constructive imagination the pupil makes the construct within the limits of his 'funds,' such as experience, intelligence, interest, and language abilities. Moreover, erroneous constructs are just as satisfying to the students as are adequate constructs, so long as the pupil does not recognize their shortcomings.

5. The Importance of the Teacher

In the discussion of the various factors which influence the quality of the constructs which pupils make, a number of suggestions have been made for improving many unsatisfactory conditions which now exist in our schools. No reference has so far been made to the influence of the teacher, yet it is of major importance. The instructional equipment in most schools is so meager that pupils must depend chiefly on the teacher for the elaboration of the brief and abstract statements of the textbook. To render this service, the teacher must himself have a thorough grasp of the ideas that pupils are expected to attain. In addition, he must understand the limits and potentialities of the 'funds' of individual pupils in order to give them efficient guidance. There is no substitute for a competent teacher.

V. Implications for Teaching

Many changes in instruction have either been explicitly urged or the need for them implied in the preceding discussion. It may be well here, however, to state in summary form what some of the most important implications for teaching seem to be.

(1) Perhaps the most fundamental implication of the theory and evidence which has been reviewed is that the curriculum should be made more responsive to the needs of the common man.

(2) There must be a substantial reduction in the number and in the difficulty of the constructs which students are required to make.

(3) In deciding the content and organization of the course of study for any grade and in determining appropriate conditions for learning, careful attention must be given to the needs and 'funds' of the children in that grade.

(4) The limitations and potentialities of language as a medium of instruction should be clearly understood by all who deal with instruction.

(5) There should be extensive and skilful utilization of concrete sources of experience, such as field trips, objects, visual aids, and authentic constructive activities.

(6) At the same time, systematic provision should be made for the improvement of language abilities, and especially of the abilities involved in reading.

(7) In the process of instruction, opportunity should be given the student to report the constructs which he has made so that, if necessary, they may be corrected and elaborated in discussion with other pupils and the teacher, as well as by additional study.

(8) Two common defects in the use of tests must be corrected: first, the overemphasis on appraisal at the end of the instructional period as compared with the use of tests as a part of the process of instruction; second, the focus upon isolated facts or upon verbal statements about them. Increased emphasis should be given to the drawing of inferences, and especially to the drawing of inferences in order to make use of the ideas which the student has attained.

(9) Finally, as implied in most if not all of the preceding recommendations, teachers must be secured or developed whose own grasp of the constructs required of the students, whose appreciation of the active nature of learning, and whose concern with the development of the individual student enable them to give adequate guidance.

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CHAPTER XII

PROBLEM SOLVING

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One may define problem solving so broadly as to make the term synonymous with learning. To do so, one needs only to point out that all learning starts with some inadequacy of adjustment, some disturbance of equilibrium—and so, with a 'problem'—and that in the process of achieving adjustment and returning to a state of equilibrium one 'solves' the problem.

According to this broad conception, the cat, when it learns to pull the cord or to depress the button and so to escape from the unfamiliar puzzle box; the student in the psychological laboratory, when he learns to run a finger maze while blindfolded or when he memorizes lists of nonsense syllables; the child in school, when he grasps the meaning of a scientific principle and learns how to apply it—all of these engage in problem solving. Again, according to this broad conception of problem solving, practically all research on learning, whether it involves meaningless or meaningful situations, skills or ideational content, laboratory or 'life' conditions, humans or lower animals as subjects—all such research is relevant to the psychology of problem solving.

I. Definitions of Problem and Problem Solving

Since all the other chapters in this Yearbook deal in one way or another with learning, the present chapter might appear repetitious, if not redundant. Yet, here is a separate chapter on problem solving. Its presence attests the belief that, for the purposes of education at least, problem solving needs to be considered separately from other kinds of learning. The separation, not an unusual one,[1] is accomplished by defi-

[1] Some psychologists (e.g., Maier, 24) go so far as to make a sharp distinction between problem solving on the one hand and learning on the other. No such distinction is here made or implied; rather, problem solving is regarded as one kind of learning.

nition. It is important that the reader carefully note this definition at the outset; otherwise, much of the ensuing discussion will be ambiguous, if not misleading.

In this chapter, problem solving refers (a) only to perceptual and conceptual tasks, (b) the nature of which the subject by reason of original nature, of previous learning, or of organization of the task, is able to understand, but (c) for which at the time he knows no direct means of satisfaction. (d) The subject experiences perplexity in the problem situation, but he does not experience utter confusion. From this he is saved by the condition described above under (b). Then, problem solving becomes the process by which the subject extricates himself from his problem, a statement which is deliberately left vague at this point in the chapter.

Defined thus, problems may be thought of as occupying intermediate territory in a continuum which stretches from the 'puzzle' at one extreme to the completely familiar and understandable situation at the other. In the case of puzzles, the nature of the task may vary from the wholly novel (which the learner has no means of solving or escaping) to the slightly known (in which the learner may recognize vaguely where to work, though he does not know what to do). His present experience is one of bewilderment, and this is brought on by the strangeness of the situation and its lack of meaning to him. If he is successful in solving the puzzle, his success is the result of accident, and the solution is not likely to be retained or to be transferable to other similar puzzle situations. In the case of completely familiar and understandable situations, no problem exists, as is true of puzzles, for the reason that the learner has available satisfactory responses which have been habituated, and there is no uncertainty as to procedure.

1. The Subjective Character of Problems

The criteria by which problems are set off from other learning tasks are, with the exception of the first, wholly or largely subjective. To some, this fact will make the definition unpalatable. Yet, the criteria could scarcely be other than subjective, for the crux of the distinction between problems and other situations lies in the peculiar relationship which exists between the learner and his task. It is a matter of common observation that what seems objectively to be the same situation may constitute for one person a puzzle, for another a problem, and for a third a condition with which he is thoroughly acquainted. Research,

too, has amply demonstrated the truth of this statement. Of the many pertinent psychological investigations which might be mentioned, that by Durkin (8) may be cited. When her subjects were required to construct two-dimensional puzzles, three main 'forms of thinking' were revealed, namely, trial-and-error activity, sudden reorganization, and gradual analysis. Objectively, the same learning tasks were puzzles or problems, depending upon the subjects concerned. Doty (6) has pointed out that arithmetic 'problems' are not commonly true problems at all. His most successful subjects employed stereotyped procedures which at once yielded the correct answers: For them, 'problems' were completely familiar situations. Nor did his least successful subjects face real problems: For them, arithmetic 'problems' possessed little meaning; they were puzzles, and correct answers, when found, were found fortuitously.

2. Practical Need for Special Recognition of Problem Solving

Obviously, the separation of the problem from other sorts of learning tasks is more or less artificial; and its differences are largely matters of degree. Nevertheless, there is justification for the distinction in the fact that it is with problems of the kind described above that the school is (or should be) primarily concerned. There may be a 'problem' in memorizing lists of nonsense syllables or of pairs of unrelated terms; but the school, while it must present some 'problems' of this kind, presents other problems in which memorization is but an insignificant part of the learning. These latter problems involve meaningful relations and are to be solved, not by the establishment of artificial associations, but by the discovery and utilization of those meaningful relations. There may be a 'problem,' too, in learning one's way through an unseen finger maze; but the school should present as few 'problems' of this character as are necessary for the learning situation in question. The problems offered by the school should depend for their solution, not on guessing and the habituation of chance successes, but on progressive growth in understanding.

II. Research on Problem Solving

1. Psychological Research

It is probably not unfair to say that psychological research (as distinguished from educational research) has dealt more often with puzzles

than with problems.[1] The traditional conditioning experiments have involved puzzle situations. For example, nothing in the experience of Pavlov's dogs should have led them to react by salivation to the sound of the bell. In the typical experiment of this kind the learning situation has been designedly kept simple, the better to isolate and control factors, by presenting to the subject, animal or human, two elementary aspects which must be arbitrarily related by him. This has meant that the subject has not been able to vary his reactions to any appreciable extent, thus preventing one of the essential requirements for problem solving.

In a similar way, the traditional experimentation with mazes, puzzle boxes, and the like—experimental situations which have been favored by connectionists—have called for the mastery of series or chains of acts in which the subject could hardly foresee the nature of successful responses. In such experiments the tendency has been to view the subject's behavior in terms of its ultimate consequences for success as defined by the experimenter; and errors, made inevitable by the character of his 'problem,' have been regarded as stupid, as indeed they are to the sophisticated experimenter, no matter how sensible to the naive subject. Nor has understanding of problem solving been much advanced through substituting pairs of arbitrarily associated terms for mazes and similar equipment. Nothing in the learning task and nothing in the learner's experience should be expected to cause the learner to select, say, 'four,' instead of 'one,' 'two,' or 'three' as the 'correct' associate for the stimulus word 'piano.' It in no way disparages the value of this research for other psychological purposes to say that it sheds little light on problem solving.

The last fifteen years or so have witnessed promising changes in psychological research, so far as problem solving is concerned. One of these changes consists in the attempt to set problems which 'mean' something to the subject (animal or man), or at least to envisage the learning task as it most probably is envisaged by the subject. A second change is the tendency to concentrate research interest, not merely on errors and successes, but on the way in which the subject proceeds to

[1] There is no implication here or elsewhere that psychologists are to be criticized on this score. No one can challenge the right of the research worker to attack whatever problems are attractive to him. The preoccupation of psychologists with puzzles happens to be unfortunate, merely from the standpoint of the present purpose.

attack and solve its problem.[1] The latter trend has not meant a wholesale abandonment of objective data; after all, the systematic analysis of errors, for example, reveals much concerning the pattern of behavior involved in problem solving. Rather, it has meant that the experimenter has been willing to advance explanations and interpretations, anthropomorphic, if necessary, in the case of animal subjects, but nevertheless designed to understand what the problem and its solution mean to the subject. A third change, closely associated with the second, is the greater importance now attached to qualitative descriptions of significant behavior to supplement or to replace purely quantitative descriptions. A sample study in this connection is that by Zener (52).

The three changes just mentioned have been accompanied by new orientations of two kinds: (1) the rise of field theories of learning, with consequent changes in the design of experimentation, and (2) the attempt to get at the nature of problem-solving behavior without regard to any particular systematic point of view in psychology. From the writer's point of view, the latter orientation is, at the present stage of psychological theory, much the more hopeful.

Gibson and McGarvey (10), in their 1937 summary of research, list a total of 108 studies made during the preceding ten-year period. While a number of the studies relate to concept formation and to generalization, humans were employed as subjects in all of them, and a great many are properly classifiable as in the area of problem solving. To some of these studies reference will be made at later points in this chapter. Use will also be made of several illustrative studies from the field of child development, where perhaps the most illuminating studies of problem solving have been made.

2. Educational Research on Problem Solving

The extent of educational research on problem solving is surprisingly limited. Compared with the abundance of investigations on different methods of teaching, on disability, diagnosis, and remedial measures, on the evaluation of learning, and the like, the number of research studies on problem solving is small. And this is most unfortunate, for both the opportunity and the practical need for sound research in this field are clearly apparent in the activities of the classroom. The reasons for the relative paucity of educational research on problem solving

[1] Examples of studies with animal subjects which illustrate one or both of the trends mentioned are: 2, 20, 21, 22, 25.

are not hard to find: On the one hand, the problems set in the classroom are exceedingly complicated, more so, in all probability, than those set in the psychological laboratory; on the other hand, children's behavior in the face of problem situations is so variable from problem to problem and from child to child that exact and comprehensive quantitative descriptions are most difficult to attain.

Unquestionably, problem solving has been investigated more extensively in the subject of mathematics, and especially of arithmetic, than in any other. Yet, a recent and fairly complete bibliography lists only seventy-two published experimental studies on problem solving in arithmetic. Partly because this particular body of research literature is the most extensive available and partly because it typifies so well educational investigations on problem solving in general, the discussion of this section is confined to arithmetic research. If the general tone of the discussion seems to be unduly pessimistic, the reason is that at this point plainly constructive statements are being intentionally withheld. As a matter of fact, the careful reader-between-the-lines will detect amidst the criticism much that is far from being purely destructive.

Arithmetic studies of problem solving are readily grouped under one or another of the following heads: (1) pupils' errors and difficulties, (2) pupils' work habits, (3) comparative merits of different instructional programs, (4) factors (such as familiarity of elements, size of numbers, presence of irrelevant elements, etc.) which condition success in problem solving, and (5) kinds of arithmetical problems which children should and should not be asked to solve. These will be discussed in the order mentioned.

(1) Pupils' errors and difficulties have most commonly been identified by analyzing test or lesson papers and inferring children's weaknesses therefrom. Such inferences are fraught with possibilities of mistakes (the product so often fails to reveal the process) and have usually yielded categories which are crude, ambiguous, and overlapping (e.g., "failure to understand the problem"—but why?; "use of the wrong process"—but why?). (2) Pupils' work habits have sometimes been studied by the case method and sometimes by direct individual observation and questioning. The case studies have seldom been both comprehensive and penetrating, and the observational reports have yielded items which cannot readily be combined to secure a clear picture of behavior. (3) Investigations of different methods of teaching children to solve problems have many times neglected factors which may have

been potent in determining success and, at best, have commonly employed instructional procedures which are artificial and unchildlike. In one study, for example, fourth-grade children were expected to use an elaborate system of diagramming far beyond their powers to understand and to use intelligently. In another study a child was found to have hit upon an unmathematical method of finding answers which, although on the whole rather successful, had no point in common with the method supplied by the experimenter. (4) Several factors have been found, on statistical grounds, to influence problem solving, but the precise manner in which these factors operate has not been disclosed. Indeed, at times investigators have hardly seemed aware of the importance of collecting data in this connection. It is known, for example, that children get fewer correct answers when problems contain large rather than small numbers; but in one study of this question no evidence was adduced to show that the large numbers affected anything other than the computation. There was no evidence that the process of solving the problem was influenced in any way. (5) Studies of the fifth class, those which deal with kinds of problems to be used in instruction, are only partly psychological in character; and those that are psychological have revealed little concerning the nature of problem solving as a process. For example, the objection to so-called 'absurd' problems is based upon a priori grounds. Furthermore this objection fails to take cognizance of the necessity of teaching children to detect absurdities by exposing them to instances of absurdity as one part of the task of developing skill in problem solving.

III. The Process of Problem Solving

There is little disposition nowadays to attribute problem-solving behavior to the activity of some special faculty or department of mind. Opposition to this view was well stated by Thorndike, among others, some three decades ago:

> There is no arbitrary *hocus pocus* whereby man's nature acts in an unpredictable spasm when he is confronted with a new situation. His habits do not retire to some convenient distance while some new and mysterious entities direct his behavior (p. 149).
>
> Nothing . . . looks less like the mysterious operations of a faculty of reasoning transcending the laws of connection-forming, than the behavior of men in response to novel situations (48, p. 169).

These statements bring problem solving well within the scope of all

other behavior and require that problem solving be explained in the same terms as is all other behavior.

That no new or special principles are needed to account for problem-solving behavior is conceded by psychologists of all schools. Agreement at this point, however, does not by any means imply agreement at all other points. Differences appear in the explanations of problem solving offered by the various schools. This is to be expected. But the differences are those inherent in the systems themselves; that is to say, they are general in character and hold for all behavior phenomena and not for problem solving alone. Some of these differences must have been noted in the reading of the chapters of Section I of this volume, so that it is not necessary in this chapter to consider them again in detail. Still, it may not be inappropriate for the writer, at the risk of whatever appearance of dogmatism, to venture an opinion, even though that opinion is not shared by all members of this committee. That opinion is that both in their experimental research and in their theoretical discussions, field psychologists have been much more practically helpful than have exponents of connectionism and conditioning. The latter two groups of psychologists, whether because of preoccupation with other issues or for some other reason, have not dealt very constructively with problem solving. They seem rather to have been satisfied to assure themselves that their concepts apply to problem solving as to other kinds of learning behavior.[1]

1. The Directed Character of Problem Solving

All schools of psychology accept the fact that behavior in a problem situation is no hit-or-miss, no haphazard affair; but that, instead, it has a directed character. In other words, psychologists of all theoretical persuasions recognize the selective character of behavior in the face of problems, though their explanations as to the process and the method of selection are unlike. From the outset Thorndike, for example, provided for the direction of behavior in his concept of mental set: mental set determines both what responses are made in the problem situation and what responses will be satisfying or annoying.

[1] So far as conditioning theory is concerned, similar evaluations have been voiced by others. For example, see the opening paragraphs of chapter x in Hilgard and Marquis's excellent synthesis of conditioning experimentation (13). The most successful attempts to explain problem solving in terms other than those of field theory have been made by Hull (e.g., 14 and 16).

Agreement on the directed character of problem-solving behavior was noted by Pratt (38) in his 1928 summary of experimentation in this area, and nothing since that date has led to any disruption of this agreement. On the contrary, experimental research in the intervening years has served only to confirm this conviction. A few of the later supporting studies may be mentioned in this connection.

Siipola (43) found that under certain circumstances a set may be spontaneously carried over from one situation to another with determinative influence in the second situation. That direction may be exerted even when the subject is unaware of the operation of set, has been demonstrated by Sells (42) in his studies dealing with syllogistic reasoning. None of his subjects reported the operation of set, but its presence was unmistakably present in the data collected. Sells introduced the term 'atmosphere effect,' which he defined as "a temporary set of the individual, arising within a situation, to complete a task with the one of several alternative responses which is most similar to the general trend or tone of the whole situation." Duncker (7) and Maier (26) also stress the fact of direction in problem solving. The latter attributes the direction to the learner's goal, which is a persistent stimulus; the former, to the effect of the subject's successive formulations of the problem itself.

2. Trial and Error *vs.* Insight

After the thorough treatments accorded the concepts of insight and of trial and error in Section I of this volume, one rather hesitates to revive the issues involved. Nevertheless, the importance of these concepts is probably greater for problem solving than for other types of learning. On this account, further discussion may be desirable.

Advocates of connectionism and of conditioning, in so far as the latter are concerned with problem solving, discuss this process in terms of trial and error. Placed in a strange situation, the organism tries one reaction after another until the motivating situation is met or is withdrawn or until the organism becomes satisfied or indifferent or exhausted. The point has already been made that none of these psychologists views problem-solving behavior as completely random, governed by pure chance, and utterly unrelated to any aspect of the problem situation, although uncritical students of psychology have so interpreted the term. The following quotations from Thorndike (48), all of them appearing in his *Briefer Course* of 1913, constitute evidence in this connection:

> Were the situation so utterly new as to be in no respect like anything responded to before, and also so foreign to man's equipment as neither to arouse an original tendency to response nor to be like anything that could do so, response by analogy would fail. For all response would fail (p. 149).
>
> Successful responses to novel data, association by similarity and purposive behavior are, however, in only apparent opposition to the fundamental laws of associative learning. Really they are beautiful examples of it . . . Man's successful responses to novel data . . . are due to habits, notably the habits of response to certain elements or features, under the laws of piecemeal activity and assimilation (p. 169).
>
> What [problem solvers] will do will, in every case, be a product of the elements of the situation that are potent with them, the responses which these evoke, and the further associates which these responses evoke (p. 170).
>
> Whatever else it be, purposive thought or action [and problem solving, since this topic is discussed with purposive thought] is a series of varied reactions or 'multiple response' (p. 172).

In their accounts of problem solving, field theorists employ, not the term trial and error, but such terms as 'understanding,' 'meaning,' and 'insight,' the last-named occurring very frequently. According to field theories the subject's cognitive structuring of the problem situation is crucial. In the case of the true problem, the learner interprets the situation in some way and responds to the situation in the light of that interpretation. If the interpretation and the ensuing response are in error, the learner restructures the situation as many times as may be necessary. When the situation is finally envisaged in correct detail—when 'insight' is available—the correct response follows. Such insightful behavior is impossible to the learner in puzzle situations because the essential understandings and meanings are lacking.

The term 'insight' especially has travelled a rocky road since its introduction. It has been attacked both through theoretical discussion and through research. Among the research questions which have been investigated are the following: Is insight an actuality, a fact? How prevalent or common is insight in problem-solving behavior? When, in the course of learning does insight occur, if at all? What are the criteria by which insight may be identified? Only a few sample studies can be mentioned here.

In his discrimination experiments with chimpanzees, Spence (46)

found no use for the concept as implying a special process. On the contrary, his subjects' presolution activity seemed explicable in terms of trial-and-error theory. On the other hand, Pickford (37) was impressed with the fact of insight, but describes it as having emerged only gradually during the process of hard thinking. Schooley and Hartmann (41) agree with Pickford as to the fact of insight. In their study, insight occurred suddenly "after the desired concept was formed" and gave evidence of being permanent in its effects. Matheson (28) set her subjects, nursery-school children aged between two and one-half and four and one-half, five problem situations much like those used by Köhler with apes (21). Every situation yielded a wide variety of responses, the most frequent of which was manipulation, which is to say, overt trial and error with "feelings of incapacity." Immediate solutions without preliminary manipulation occurred in only 3.6 per cent of the responses.

These four studies are perhaps enough to illustrate some of the conflicting conclusions drawn from investigations. To some investigators, 'insight' is a useless term; to others, it describes a real phenomenon. Some investigators, not mentioned here, have commented upon the immediacy of insight; others report that insight develops gradually, but that when it emerges, it appears suddenly; still others note that insight is observable in only rare instances in problem-solving behavior.

An explanation for these conflicting conclusions is to be found (1) in the criteria employed to connote insight and (2) in the learning tasks used, as well as in the equipment of the experimental subjects to deal with these tasks. The traditional criterion, namely, suddenness of appearance, has more recently been supplemented by at least two others. The term insight may, it is now suggested, be properly employed when solutions, though they do not occur quickly, are nevertheless retained and are useful in similar problem situations. The Schooley and Hartmann study cited above employed these newer criteria; their values have been even more clearly demonstrated in the work of Katona (19), which will be outlined later in this chapter.

The nature of the learning task has much to do with the appearance or nonappearance of insight. Just how understanding or insight (whatever its character) could have occurred in the Spence experiment, it is difficult to see. Pickford's subjects were delayed in attaining insight because the relationship involved (discovery of a common feature, namely, a right angle, in a series of twenty-seven drawings of geo-

metrical figures presented one at a time) was by no means readily identifiable to the unsophisticated learner. On the other hand, the relationships which Schooley and Hartmann's subjects had to apprehend —action-agent, agent-action, attribute-substance, substance-attribute, and the like—such relationships are, when not deliberately made difficult, well within the rather immediate grasp of the learner; and so, in their study, insight could appear somewhat sooner than was the case with Pickford's subjects. Matheson's problems were apparently very difficult for the particular subjects she used, and as a consequence immediate, insightful solutions were rare. That the problems were too difficult for most of her subjects (and hence were really puzzles to them) may be inferred from the prevalent "feelings of incapacity" and from the fact that the tendency to produce immediate solutions correlated positively with both mental and chronological age.

The theoretical objections to the term 'insight' have already been suggested. If by 'insight' is meant the operation of some power which transcends ordinary experience, the objection is that there is no such thing, or certainly no proof of such a thing. And the objection would seem to be sound. If by 'insight' is meant the more or less sudden apprehension of subtle relationships critical to the solution of the problem, the objection is that the idea is already sufficiently well provided for in the vocabulary of conditioning and connectionism: in the process of trial and error minor bonds or connections or conditioned responses for some reason or other attain potency. The second objection may, for *practical* reasons, be less sound. To the average teacher it is much more meaningful to say that a problem is solved by insight (in the nonmagical sense) than to say that it is solved by the operation of conditioned responses, bonds, or connections which up to this point have been underpotent. After all, teachers deal directly with understandings and not with bonds.

Yet there is one danger in accepting the term 'insight,' and this danger arises not so much in psychology, where it will likely be used for descriptive purposes, as in education. Educationalists are prone to appropriate psychological concepts (or, at least the words for the concepts) whenever they can use them to their own ends. In these circumstances it may be forgotten that if insight occurs in the problems set by the school, it occurs through the reorganization of previous learning.[1]

[1] Exception is noted in the case of some experiences, notably in perception, which have been mentioned by Gestalt psychologists.

Many educationalists may be apt to overlook this prerequisite to insight and invoke 'insight' (now a magical power) to perform impossible feats. The longer road is the surer road: first, the essential experiences, then the reorganization of those experiences, bringing with it insight, when the problem is adjusted to the level of the child's understanding.[1]

3. Errors in Problem Solving

Some attention has already been given to educational investigations relating to errors in problem solving. It was pointed out that this research has usually ended with the listing of kinds of mistakes, together with their comparative frequency. Few investigators have sought to get beneath the errors in order to ascertain their causes. Yet, it is this latter knowledge about errors which is of most vital importance for the improvement both of initial and of remedial instruction.

More fundamental explanations of errors than those occasionally met with in educational literature have been offered by several psychologists, and these explanations should be suggestive in the guidance of school learning. Maier (26) accounted for errors in problem solving as the result of the inflexibility of the reasoner's set: The habitual response has the right of way and blocks out other possible reactions. Duncker (7) proposes a similar explanation: Familiar functions of the material dealt with suggest themselves first and prevent a 're-centering' of the object to the new function. Woodworth and Sells (51) explain errors on the basis of 'atmosphere effect.' All problems have an 'atmosphere' which varies from great strength to weakness and is proportionately determinative of reactions. On this basis they were able to predict with considerable accuracy what subjects would do with sets of syllogisms. Symonds (47) attributes errors to failure to isolate and define the values sought in problems prior to solution.

IV. Growth in Problem-Solving Ability

The most extensive research on problem solving with children has been done by Piaget and his associates at the Maison des Petits, in Geneva, Switzerland. In their four volumes (33, 34, 35, 36), data are reported from studies conducted largely by means of direct observation, testing, and questioning in natural situations and covering a large variety of problem situations.

[1] Melton's suggestion (29) that the term 'approximation and correction' be substituted for 'trial and error' may be one way of preventing unfortunate misinterpretations.

Much of this chapter, an amount of space which may appear to be disproportionate, is given to Piaget's account of the development of ability in problem solving. The writer had as an alternative the possibility of citing numerous other valuable researches, but these would have had to be dismissed with a word. The decision in favor of Piaget's research was made in full recognition of the loss of prestige which it has suffered during the past few years. Some of Piaget's investigations have been repeated in this country and elsewhere, but with different results; and some of his interpretations have been challenged. Nevertheless, with all their limitations, Piaget's studies seem to provide the most illuminating single description of the way in which children attain power in problem solving. At the conclusion of this section, where the major criticisms of this work are considered, it will be possible to recognize in part some of the efforts of American and English students of child development. It will also be possible through these criticisms to shed further light on the course of development of problem-solving ability, which is the subject of this section.

Piaget represents growth in problem solving as influenced by two sets of factors. The first set is highly personal and narrowly individualistic, the result of the egocentrism of early childhood. Opposed to the first set of factors is another set, social factors, which are steadily imposed upon the child and which have the effect of leading him to substitute objective reality for his own subjective schemas and to replace his illogical, if personally satisfying, mental processes by others which are rational and can meet the requirements of impersonal appraisal. The conflict between the two sets of factors is resolved finally in favor of the social factors, though the egocentric factors are by no means easily, quickly, and completely surrendered.

The egocentricity of young children reveals itself in problem solving (1) in lack of logical consistency, (2) in inability to understand relationships, (3) in absolutism, (4) in juxtaposition, and (5) in syncretism.[1] To explain these terms: (1) Children up to the age of seven or eight are conscious neither of the grounds of their thinking nor of the need to satisfy others as to the validity of their conclusions. Whatever decisions and conclusions suit their whims and desires are accepted uncritically. (2) Such abstract relationships as those within

[1] Curti has summarized exceedingly well the import of Piaget's theories. See reference 4. Curti's synthesis is followed here, rather than the detailed reports in Piaget's four volumes.

the family (between brothers and sisters, between parents and children, etc.) and as those involved in the ideas 'right' and 'left' are not readily understood by young children. Their egocentricity prevents their stepping outside themselves, as it were, and viewing matters objectively. (3) That the meanings of terms and ideas are relative is not clear to children. (4, 5) In the earliest years children react to unanalyzed wholes (syncretism); all things are connected and assimilated into the patterns of their personal plans and purposes. Gradually, under social pressure, they learn to react to differences and parts, but they are apt to do so without relating the parts to their wholes. Their thinking is discontinuous, one idea and statement following another without logical connection (juxtaposition).

In general, according to Piaget, prior to the age of seven or eight, reasoning is a mental experiment, consisting of jumbled, unconnected judgments without awareness of relations. Until then, children find it exceedingly difficult to solve problems wholly on a verbal basis. Instead, they get along much better if they can manipulate objects or at least think in the presence of the objects with which the problems are associated. After seven or eight, children grow steadily in their control of purely verbal processes and in their awareness of their own mental operations, but it is not until the age of eleven or twelve that they are really facile in verbal problem solving and are capable of reasoning in the adult sense of the term.

Piaget's work has been subjected to criticism. For example, other investigators have set earlier ages than eleven or twleve as the time when children begin to reason. To illustrate, Roberts (40), Heidbreder (12), and Hazlitt (11) found some evidence of elementary reasoning at age three; Maier (27) and Gellermann (9) found similar evidence at age five, and Moore (31) at age six (the lowest age tested). The issue here is two-fold; it involves (1) a definition of reasoning (Piaget uses this term rather than problem solving) and (2) the nature of the problem task. In conformity with his definition of the term, and because of the learning tasks which he prescribed for his subjects, Piaget sets eleven and twelve as the age when children can first reason. Others who define problem solving differently and present different kinds of problems to their subjects specify different ages as the time when problem solving is possible. The relation between the problem on the one hand and the resulting behavior on the other has been repeatedly emphasized throughout this chapter. What one does in a

problem situation is, in other words, largely a function of the type of problem one faces. Other investigators than Piaget have made use of tasks which could be (even had to be) worked out by means of overt manipulation. In these circumstances their subjects solved their problems by what Piaget calls "empirical thinking," a process which he himself illustrates as occurring long before the age of eleven or twelve.

Piaget's failure to consider sufficiently the prejudicial character of the problem tasks with which he worked may be taken as the first major criticism of his work. The second criticism attaches to his definition of reasoning. To Piaget, reasoning is the highest type of formal, systematic thinking, in which one starts with hypotheses, verbally presented, and works through to a judgment by rigorous processes which are themselves entirely verbal. The objections to this definition are, first, that this kind of thinking is rare; second, that it overvalues verbal expression as a measure of thinking; and third, that it tends to encourage the notion that young children cannot solve problems of any kind. As a matter of fact, children at any age are capable of solving problems which are suited to their experience, understanding, and behavior equipment, though their processes may be largely nonverbal. Nevertheless, there is a sound caution in Piaget's definition. It should prevent teachers from expecting too much of children. It is futile, perhaps dangerous, to ask children to solve problems which are beyond their powers or to solve problems by exclusively verbal processes before they can do so. In a word, if Piaget's critics remember that he is interested in a particular kind of problem solving, certain of their objections may be withdrawn.

A third criticism of Piaget's interpretations seems to be sound. It is true that here and there Piaget states that his age levels in reasoning are tentative; nevertheless, the reader is most likely to gain the impression that children at certain rather definite ages achieve equally definite levels of thinking. The fact is that children do not move from level to level in an all-or-none way, but that at any one age they reveal the characteristics of several levels of thinking as they deal with different kinds of problems. Moreover, it is probably true that the changes in problem solving which Piaget attributes to age are better explained as the effects of increases in general experience and in control over language. In this case, age makes its contribution chiefly by providing opportunity.

A fourth criticism also seems to be sound. Piaget's account makes adult reasoning quite unlike children's problem solving. In rebuttal two statements may be offered. The first has already been made: The highly logical reasoning which Piaget makes typical of adults is really uncommon. The second is, as Hazlitt suggests (11, p. 361), Piaget has an "exaggerated view of the logicality of adult thought." Adults at times betray in their problem solving the same kinds of logical weakness, the same effects of egocentricity, and the same tendency to overt manipulation and movement that are so prominent in children's problem solving. These facts have been nicely demonstrated in the study made by Abel (1) on "unsynthetic modes of thinking among adults." The experimenter read to her adult subjects material of a high degree of difficulty. The subjects in turn (1) wrote out what they remembered and (2) then read their reports to other naive adults. (3) The last-named then wrote out what they recalled from the reading in (2). A comparison of the written accounts with the original selection disclosed clearly the operation of the "prelogical modes of thinking" characteristic of children when confronted with problems of equivalent difficulty.

V. Teaching to Solve Problems

Some entertain grave doubts concerning the practicability of efforts to develop or increase ability in problem solving. Such persons take the position that a given individual is a thinker, or he is not a thinker, and that in the latter case nothing much can be done about the matter. In support of their position they are able to cite a good many educational investigations in which attempts to improve problem solving have been futile.

One does not need to deny the genuineness of hereditary limitations when one maintains the practical certainty that every individual can be made a better solver of problems than he now is. This is but another way of saying that few persons, indeed, attain their highest possible level of ability in problem solving (or in anything else). The task of the school is just this, to make all children better in problem solving than otherwise they might be.

1. Questionable Educational Practices

True, not all efforts to improve problem-solving ability have proved successful. The reason probably lies in the use of methods which are powerless to produce this end. A favorite method is to train children

in some technique of analysis, many of them modeled more or less closely on Dewey's classical steps in the complete process of analytical thought (5). This method is particularly well exemplified in arithmetic. From the outset of systematic instruction in problem solving, say in Grade III, children are directed to ask and to answer certain set questions: (1) "What is asked?" (or, "What am I to find?"); (2) "What is given?" (or, "What do I know?"); (3) "What process or processes should I use?"; (4) "What is the probable answer?" (the last question being followed by actual computation).

Two major criticisms may be made of this general method of teaching children to solve problems, whether it is employed in arithmetic or in any other sphere of school experience. In the first place, the method of step analysis represents a logical pattern of thinking which may or may not characterize expert thinking on the part of adults, but which certainly has not yet been shown to characterize good thinking on the part of children. According to this method of teaching, a formal abstract pattern, possibly suitable to adults, is imposed upon children before they are ready for it. A preferable procedure is first to ascertain the level of thinking which children have attained and then to lead them on to more mature and economical levels as rapidly (but only as rapidly) as they can adopt them.

In the second place, this method puts too much trust in technique alone and disregards other essentials in effective problem solving. It is a commonplace that, to think clearly and well, one must have something with which to think. The 'something' in this statement refers to facts, to meanings and understandings. Without these, a technique of problem solving is useless. It is precisely at this point that many modern instructional practices are deficient. Only praise is to be given the new emphasis which has been put upon the necessity of having children 'think' instead of 'memorize,' of having them reason out conclusions for themselves rather than complacently and docilely accept conclusions given them by others higher in authority. But there is danger in the oft repeated statement that "it is more important to teach *how* to think, than *what* to think." Neglect of understandings and meanings, the materials with which one thinks, may well result in a complete stultification of thinking or, worse, in an over-confidence in judgments and decisions reached in the absence of relevant data.[1]

[1] In this connection as well as at later points in this discussion, Professor Horn's chapter on the development of meanings is particularly pertinent.

Besides training in step analysis, two other educational methods of teaching children to solve problems may be considered very briefly. Both are as artificial as is step analysis; and correspondingly, both are predetermined to limited success.

One of these methods is to supply at the outset certain shortcuts which sometimes 'work,' but which cannot always be trusted. For lack of a better term, this method may be named the method of teaching 'cues.' Not long ago the writer observed a sixth-grade teacher in the midst of a remedial lesson in problem solving. On the blackboard was a problem telling of a merchant who had purchased and sold a certain article at a profit. The problem was to find how much he had 'gained.' The operation required was, of course, subtraction. Having elicited this answer from some child, the teacher went on to explain that the word 'gain' in a problem always indicates the need for subtraction. The tragedy of this instruction does not lie merely in the fallibility of the advice given: After all, 'gain' may occur in addition, multiplication, and division problems as well as in subtraction problems. The greater tragedy lies in the failure of the teacher to develop a more fundamental meaning, namely, an understanding of the purpose of subtraction and of its nature. Even had the teacher's advice been correct in all instances, her pupils could scarcely have been more *intelligent* in their subsequent reactions to subtraction situations.[1]

The last method of teaching problem solving to be commented upon relies upon training in some function more or less related to problem solving. To illustrate: Many problems are presented through reading and are solved, in part, from data obtained in reading. On this account, a not uncommon experiment and classroom practice is to train all pupils in reading as a means of improving problem solving. It should be clear that the effectiveness of this procedure is contingent upon individual needs. For example, such practice in reading may prove helpful if the child is really handicapped in problem solving by his inability to get sense out of the printed page and to locate essential data. On the other hand, no such promising results can be expected in the case of the child who, however proficient or deficient in reading, is lacking in basic understandings and rich concepts.

[1] Some of the effects of children's adopting or being taught 'cues' instead of basic understandings have been shown by McEwen (23).

2. Katona's Investigation

That the success of methods of teaching problem solving is vitally dependent upon the character of the methods used has been recently and emphatically demonstrated by Katona (19). It will be possible here to review only briefly the two of Katona's investigations which are most relevant to the present purpose, and it will be necessary to omit all reference to Katona's important theoretical discussions and qualitative data. Even with this condensation, the account of Katona's experimental procedures and findings may seem overlong, especially in view of the fact that the pertinent research of other investigators must be neglected. On the other hand, more may be gained from an extended consideration of a single good study than from greatly abbreviated comments on a larger number.

The first of the Katona experiments involved the learning of card tricks, illustrated by the following: thirteen spades to be prearranged so that when the odd-numbered cards (first, third, etc.) are dealt face up, the even-numbered cards being placed unseen at the bottom of the dwindling pack, the visible order is ace, deuce, three-spot, and so on to the king. The experimental procedure involved four parts: foretest, practice, test, and retest.

In the foretest the trick described above was shown to the subjects to make sure that they were unfamiliar with it. In the practice period, Group Mem. ('memorizing' group) learned by heart the order of cards, not for the original thirteen-spade trick, but for Tricks 3 and 4, which were similar to it. Their practice period lasted four minutes, as did that for Group Und. ('understanding' group). This group had no experience at all with Trick 4, but had explained to them the principles according to which Trick 3 was performed. The third experimental group, Group Con. ('control' group), had no practice period at all.

In the test phase of the experiment the subjects of the three groups attempted to solve three tricks: Trick 1 (an easy adaptation of Trick 3), Trick 2 (a difficult adaptation of Trick 3), and Trick 3 (principle learned by Group Und., order of cards memorized by Group Mem.). The records showed Group Und. clearly superior to the other two groups in the two new tricks (Tricks 1 and 2) and equal to Group Mem. and superior to Group Con. in Trick 3.

Thus far in his experiment Katona had employed two criteria of comparative success in problem solving, namely, solution of a problem after differing kinds of practice, and ability to transfer the technique

of solution to new problems. In the fourth phase, the retest, which took place four weeks later, Katona again made use of the second criterion and added a third, comparative retention.

The retest consisted of Trick 3 (see above), Trick 4 (wholly unfamiliar to Group Und., order memorized by Group Mem.), and Trick 5 (a new trick for all; like Trick 2, but easier). This time Group Und. excelled both other groups in all three tricks, their superiority over Group Con. being represented by the ratios 4 or 5 to 1, and over Group Mem. from 1½ to 1 to nearly 3 to 1 (percentages of correct solutions in all cases).

Katona interprets the data from the experiment as indicating that teaching of problem solving based upon understanding is more fruitful than teaching based upon memorization. Yet, as Katona states, the first experiment left undefined the term 'understanding.' Understanding may differ in kind and in amount; different methods of teaching may produce different 'understandings'; and it was therefore necessary to explore further the meaning of 'understanding.' This Katona did in what is here called his second major experiment,[1] in which match tricks were substituted for card tricks. An example, Katona's Task 1, is that of changing the five equal squares of Fig. 1 (or any of its three other possible arrangements) to form four equal squares by altering the position of three matches. One of the solutions appears in Fig. 2.

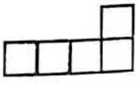

Fig. 1

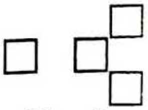

Fig. 2

The design of the second experiment was like that of the first. In the foretest the experimenter demonstrated a match trick and selected as subjects only individuals who knew neither the trick nor the principles governing its solution.

The practice period lasted for ten minutes for all groups except Group Con. ('control') which had none, and was employed differently for the experimental groups, of which there were three. Group Mem. learned to solve (or saw the solution of) Tasks 1 and 8 (not here described) under conditions which were intended to make the learning

[1] Some of Katona's other experiments are perhaps more suggestive than the one here reviewed, but the number of cases involved tended to leave interpretation somewhat ambiguous.

'senseless' by exhibiting only 'inadequate grouping.' No explanation of any kind was given, while Tasks 1 and 8 were 'solved' six times in this way. The subjects of Group Help were first allowed to study Task 1 (later, Task 8) for thirty seconds, to see if they could solve it. Then the solution was drawn on the blackboard in a series of steps, the whole series being left so that the subjects could independently trace the solution through all its stages. As for the third group, Group Arith., 'meaning' was given to Tasks 1 and 8 by the experimenter's reading slowly the *principle* involved in the solution (namely, the elimination of lines 'with double function') and by his demonstrating the application of the principle to both tasks.

The test phase followed at once and presented four new tasks. The groups ranked in order, from poorest to best: Con., Mem., Arith., and Help, whether the scoring was done in terms of percentages of correct solutions or of weighted values for attempted solutions.

The retest, coming four weeks later without practice or warning, comprised two practiced tasks, two new tasks, and two previously tested tasks. Group Con. was clearly the poorest on all three sets of tasks, and Group Help was best. The significant data according to Katona, are those for the new and practiced tasks. Group Help solved new tasks about as well as previously solved tasks, but this was not true of Group Mem. Group Arith., which the experimenter rather obviously expected to do very well since they were given 'meaningful' instruction, was better than Group Con. in all sets of tasks but better than Group Mem. only on the two new tasks. The reason for their failure to do better is not discussed by Katona but may be attributed to the ambiguity of the 'principle' given them.

Katona's experiments have been published for too brief a time to receive the criticisms which are sure to come. Some of these criticisms can be foreseen; for example, that not all procedures for successful solutions were tried out. It is not impossible, but rather highly probable, that intelligent solutions arrived at by the individual subject with no help from the experimenter might have been superior to any of Katona's types of meaningful instruction. Yet, whatever criticisms develop, Katona's studies will not be shaken at the points for which they are cited in this chapter. Katona has demonstrated, first, that problem solving which is based upon understanding is superior to 'problem solving' based upon memorization; second, that understanding is a matter of degree, that varying degrees of understanding affect

problem solving differently, and that the degree of understanding engendered is a function of the kind of instruction given; and third, that that form of instruction which enables the learner best to *organize* his previous experiences or learnings is to be preferred to other kinds.

3. The Function of Practice

The role of repetitive practice in improving ability to solve problems is closely parallel to its function in other kinds of learning. Practice of the same response merely increases facility in producing that response, whatever its nature and its level of usefulness and maturity. If one repeats the definition of some term without understanding its meaning, one cannot through repetition acquire meaning for the term, however proficient one may become in saying or writing or thinking the definition. One does not come to meaningful mastery of the combination $3 + 4 = 7$ by counting, "one, two, three . . . seven," no matter how many times one counts it. Practice in counting serves but to improve facility in counting; the level of response and meaning remains unchanged. For the definition and the arithmetic combination to possess meaning, the learner must respond to the definition and the combination in a variety of ways.

So, in the case of problem solving, while repetitive practice on the same solution with the same problem does increase facility in that solution, it does not make that solution available for other problems, even those closely similar. This sort of practice, on the contrary, seems to restrict the availability of the solution. On the other hand, practice in applying the solution, or the method of solution, to different problems has the effect of widening the availability of that solution. These facts are amply demonstrated in the findings of Katona reviewed above.

So far as education is concerned, in order to assess the value of practice in problem solving one needs to know (1) precisely what is being practiced and (2) precisely what *should* be practiced, that is, what outcomes are sought. The effects of practice in problem solving, as reported, have been so variable as to warrant the belief that not all subjects have practiced the same thing or in the same way. Monroe (30), after a statistical analysis of test papers, was impressed by the fact that his subjects attacked arithmetic problems in a purely haphazard manner. Apparently, to his subjects, arithmetic 'problems' were puzzles, to revert to the term with which this paper started, and prac-

tice consisted chiefly in guessing. On the other hand, as has already been mentioned, Doty's best problem solvers (6) made regular use of routinized procedures to secure correct answers without thought on their part. Practice had had the effect of enabling them to discover meanings and relationships and to short-circuit the process of thinking. Still again, Bradford (3) found that his subjects insisted upon trying to solve arithmetic problems which could not be solved because of lack of essential data. In their case, practice had set up the blind expectation that any quantitatively described situation, no matter how imperfectly presented, must somehow be solvable by juggling numbers.

4. Practical Suggestions for Developing Ability in Problem Solving

In view of the limited support from competent research, some risk is involved in any attempt to formulate practical suggestions for improving ability in problem solving. Nevertheless, the seriousness of the need for improvement in instruction at this point requires that the attempt be made. The first eleven suggestions below seem to follow from the presentation earlier in this chapter. The last is a paraphrase of Parker's excellent analysis (32) of the guidance of learning in particular problem situations. This analysis, published nearly twenty years ago, has not, to the writer's knowledge, been improved upon.

a) A supposed problem situation cannot be assumed to constitute a true problem situation to all learners. So important and so large are differences in general ability (intelligence), in past experience, in present motivation and understanding, and in other factors that some learners will almost certainly respond as to a puzzle situation or as to a completely familiar situation. In other words, whether a learning task will be a problem to the learner is dependent upon peculiar relationships between the learner and the task.

b) There is little that is educational in attempts to solve puzzles as puzzles. As long as a learning task remains a puzzle, means of solution cannot be logically selected, and success must be accidental. In such a case, the successful response, not being understood, is not likely to be remembered nor likely to be useful in similar situations. When a puzzle must be presented, the learner can be helped to analyze the task and to organize his attack, the puzzle thus being converted as much as possible into a problem.

c) When a learning situation is intended to be a problem, the relationships necessary to its solution should be (1) well within the understanding of each child and (2) identifiable by him with reasonable effort.

d) Skill in problem solving is partly a matter of technique and partly a matter of meanings and understandings. Highly formal and abstract techniques should never be imposed upon the child. Instead, they should be viewed as the end-products of development. Teaching should start with whatever technique the child uses proficiently and should guide him in the adoption and use of steadily more mature types of problem solving.

e) The meanings and understandings essential to the successful solution of educational problems cannot be given to children. Like the techniques of problem solving, they, too, must be carefully developed through a wide variety of appropriate experiences (see chapter xii). There is reason to believe that meanings and understandings are most useful in problem solving when they have themselves been acquired through the solving of problems.

f) As Katona has suggested, the experience which is most valuable for solving problems is *organized* experience. This means that, to the limits desirable and possible, solutions to problems should be summarized clearly, stated verbally, and generalized.

g) To be most fruitful, practice in problem solving should not consist in repeated experiences in solving the same problems with the same techniques, but should consist in the solution of different problems by the same techniques and in the application of different techniques to the same problems.

h) A problem is not necessarily 'solved' because the correct response has been made. There is danger in allowing the child to adopt this notion. After all, the successful response for problems, as for puzzles, *can* be found by chance. A problem is not truly solved unless the learner understands what he has done and knows why his actions were appropriate. Better tests of problem solving than the correctness of the solution, or answer, even when immediately arrived at, are (1) whether the method of solution is retained and (2) whether it can be employed subsequently in similar problem situations.

i) The mistakes children make when they are really trying to solve problems are not 'corrected' by providing them with the 'right' solution. They are correctly solved only (1) when the weakness in technique has been exposed and has been supplanted by a sounder attack, or (2) when the needed meaning or understanding has been developed, or (3) when both (1) and (2) have been taken care of.

j) Part of real expertness in problem solving is the ability to differentiate between the reasonable and the absurd, the logical and the illogical. Instead of being 'protected' from error, the child should many times be exposed to error and be encouraged to detect and to demonstrate what is wrong, and why.

k) A problem-solving attitude, an inquiring and questioning mind, is a desirable educational outcome, and it is possible of development. The practice of 'learning' by cramming does not produce this outcome, nor does the practice of accepting from others truths and conclusions which ought to be established by the learner himself. The attitude *is* produced by continued experience in solving real problems, one consequence of which is that the learner comes to *expect* new problems and to look for them.

l) Guidance of learning in the case of a particular problem task may well take the form of one or several of Parker's suggested activities:

(1) Help children to formulate the problem clearly, and

(2) See that they keep the problem continuously in mind.

(3) Encourage them to make many suggestions by having them analyze the situation, recall similar cases and the rules or principles of solution which there applied, and guess courageously.

(4) Get them to evaluate each suggestion. This involves maintaining a state of suspended judgment, criticizing the suggestion by anticipating objections and consequences, and verifying the conclusions by appeal to known facts, miniature experiments, and authorities.

(5) Have them organize their process of solution by building outlines, using diagrams and graphs, taking stock from time to time, and formulating concise statements of the net outcomes of their activity.

VI. Summary

The content of this chapter has been both psychological and pedagogical, both theoretical and practical. Problems have been differentiated from other types of learning situations which evoke behavior. Stress has been continually given the fact that the subject's behavior is a function of his apprehension of the stimulating situation. This means, so far as the school is concerned, that children engage in true problem-solving behavior only when they envisage their learning tasks as problems. Psychological theory and research as well as educational research and practice have been examined, the purpose being to ascertain procedures by which ability in problem solving may be developed. The social importance of this ability has been assumed, as

has also the school's responsibility for its development. The chapter has been concluded with a series of suggestions which, it is hoped, may be useful for improving instruction in problem solving.

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CHAPTER XIII

ORGANIZATION AND SEQUENCE OF THE CURRICULUM

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One of the principal ways in which a school attempts to direct the learning of its pupils is by controlling the situations which make up its curriculum. The child's responses to these situations are determined not only by the nature of the content of the curriculum, but also by its organization and sequence. The selection of content is a problem which concerns others as well as psychologists, but the organization and sequence of whatever content is selected involve decisions which are primarily within the province of psychology. It is the function of this chapter to examine the contributions that psychology can offer to the curriculum maker.

In the theoretical chapters which make up the first half of this Yearbook, the contrasting positions of different theories are quite properly presented as sharply as possible. However, in attempting to apply these chapters to problems of the curriculum maker, the writer's effort will be to search for agreement rather than difference, and to find how much common ground the psychology of learning affords for curriculum practices. The amount of substantial agreement that exists, as revealed in the theoretical chapters, warrants a considerable degree of positive application.

The theoretical chapters show that some curriculum practices which have been defended on psychological grounds never had an adequate basis in psychology for their defense. For example, the practice of building a curriculum by a summation of unit skills to be learned through drill was frequently justified on the grounds of a supposed connectionist psychology which required the exercise of many discrete and unrelated items. As indicated in Gates' chapter, the authors of connectionism never held views which would justify such practices. Many of the criticisms of 'psychological atomism,' as applied to the

curriculum, have been occasioned by the uncritical reading of a theory whose authors have been misinterpreted. One of the main contributions of this Yearbook should be to reveal to educators how much agreement concerning the psychology of learning exists among competent psychologists. An emphasis on common agreements may produce less emotional stimulation at the meeting of the National Society, but it will make a much greater contribution to developing a sound curriculum.

I. Definition of the Curriculum

Inasmuch as this chapter deals with the organization and sequence of the curriculum, it will be appropriate to offer a definition indicative of the writer's use of the term. Since the writer is not a 'curriculum specialist,' this definition will certainly not satisfy some readers. However, it will at least serve the purpose of making clear what is meant when the term is used in this chapter. By the term 'curriculum' the writer means whatever content is used purposely by the school as a stimulus to learning. This content may at times be chiefly intellectual and at other times manual; it may be subjects or it may be activities, organized or unorganized. The school must use some kind of content, a curriculum, to stimulate learning. This curriculum might conceivably be very different from the present orthodox one, but whatever the nature of the curriculum, it must be presented to the pupil with some degree of organization (or disorganization) and in some sequence. The writer does not conceive of a contentless education. The slogan "teach the child, not the subject" is frequently misinterpreted, and has resulted in many indefensible applications. Some stimulation is necessary to produce a response, and the school's curriculum is the total of those situations which are purposely used to produce favorable learning responses. It should be noted that much learning may result from stimuli received in school which are not part of the school's purposeful activities. The range of these noncurricular stimuli depends on the breadth of the school's concept as to what its purposeful functions are. It should, of course, be apparent that the writer's use of the term 'curriculum' is broader than the term 'school subjects' as ordinarily used.

II. Basic Problems Relating to the Curriculum

This chapter will be concerned with an application of the psychology of learning to four major curriculum problems, each of which must be answered in some fashion by anyone who plans a curriculum. Each

problem will be outlined briefly and then the remainder of the chapter will be given to a consideration of the related psychological factors.

The first problem has to do with the organization of the curriculum. Should it be organized at all, or should it consist of more or less unrelated projects which arise from day to day in the experience of children? If the curriculum should be given some systematic organization, just what should be the basis of this organization? Should it be in terms of the logical relationships within the subject or activity concerned, or should it be in terms of difficulty of learning, or pupil interests, or what? How should the details be related to the wholes; the concretes to the abstract generalizations? And who shall determine the nature of the organization—pupils, teachers, or specialists? Does the psychology of learning have anything to contribute to an attempt to answer such questions?

A second problem in curriculum making has to do with the sequential arrangement of whatever content is selected. Where should the learner begin, and in what order should he proceed toward the goals set up in the curriculum? How should curriculum materials be related to the maturity of the learner? How should the curriculum be arranged to provide for maintenance of learning? Does psychology have any general principles that could guide in determining the sequential arrangement of a curriculum?

A third problem, which touches nearly every attempt at curriculum construction, is concerned with how to make the curriculum carry over or transfer to wider areas of living than are found within the school itself. Do some curriculum materials transfer better than others? Is this wider transferability affected by the organization and sequence of the curriculum? Is the possible transfer affected by the proportion of specifics and generalizations in the curriculum, and what should be the relationship of these two factors? How are different methods of teaching related to the problem? This matter of transfer is one of the central issues in curriculum making. Any theory of education finds this an inescapable problem.

In the fourth place, there is the problem of the proper relation between the curriculum and the child being educated. What the curriculum does to the learner is a matter that is of primary concern to all educators. Does the psychology of learning recognize this problem and does it offer any help to a clearer understanding of the proper relationship between pupil and curriculum?

Each of the foregoing problems is of joint concern to the psychologist and the educator. What can be found in the theoretical chapters in the first half of this Yearbook to give practical help to those who are responsible for making curricula?

III. How Should a Curriculum be Organized?

The answer to the question of organizing a curriculum lies somewhere between no organization at all and a fixed and rigid formality. Whatever answer is given must be in terms of the learner, since the only purpose of any curriculum is to stimulate learning. In order to be effective, a curriculum must stimulate desirable responses. It must be judged by the nature of the responses that it elicits. Obviously, this implies that educators, and society in general, must reach some agreement as to what responses (objectives) are desirable.

All theorists agree in emphasizing the importance of response in learning. In the last analysis a curriculum is what it causes pupils to *do*. Guthrie, in his chapter in this Yearbook, stresses the importance of response in repeated statements as:

> We learn only what we do (p. 24).
>
> In its simplest form, teaching consists in inducing by one means or another some desired pattern of movement, whether of the whole body, of hand and eye, or of speech. The movement must be induced in the presence of stimuli that we wish to make its cues or signals (pp. 24-25).
>
> When we assert that a child learns only what he does, this includes that quiet behavior that may be called *inner speech*. It is quite possible, then, to learn with comparatively inactive listening. But if listening is actually passive, all that is being learned is to disregard the noise made by the speaker (p. 54).
>
> In order to make listening profitable (or school work of any kind, for that matter) *it is essential that the student be led to do what is to be learned . . . . A student does not learn what was in a lecture or in a book. He learns only what the lecture or book caused him to do* (p. 55).

The stimulus-response concept is sometimes associated with an atomistic psychology. That this need not be the case is emphasized by Woodworth in the following statement quoted by Gates (pp. 144-45).

> A complaint sometimes brought against the stimulus-response conception is that it is 'atomistic.' An atomistic psychology attempts

> to explain any total activity by analyzing it into its elements, and this kind of explanation is sometimes felt not to get us far in psychology. However this may be, the formula is not essentially atomistic. Either S or R may be as big and complex as you like . . . such an aggregate of stimuli as is presented to the eye on looking out of the window works as a single combined stimulus when it arouses the response, 'What a beautiful day.'

The field theorist's position is expressed by Hartmann in one of his summary statements: "The conditions of learning should provide opportunity for the continuous modification and change of the pattern of response" (p. 207).

It is clear that any satisfactory curriculum must be more than a body of content to be passively memorized verbatim. It ought not to result in the acquisition of a set of verbalisms. It must in some way succeed in arousing the learner to some active form of response, or it cannot be effective. The traditional school-subject curriculum has been criticized chiefly on the ground that it fails to stimulate active responses in pupils. Substitutes have been offered under various names, although all are characterized by the same central idea. Thus, these various ways of learning by doing have been called projects, activities, life-situations, etc., but the goal of all of them has been more self-activity and more vigorous responses from pupils. Some of these reforms have emphasized curriculum situations that are 'lifelike' on the ground that this would arouse greater interest and more active responses from pupils. The aim of all these reforms has been laudable. They have recognized a psychological truth of great importance and have tried to adjust the curriculum to it. They have precipitated certain clashes resulting in antagonistic attitudes between groups that have attempted to push each other into extreme and untenable positions.

For example, the group that took as its slogan "learn by doing" has often used such a narrow definition of 'doing' as almost to exclude intellectual efforts in favor of overt muscular behavior. This has been evidenced in frequent clashes between the practical arts group and the language groups in school. It is also observable in some of the arguments for a 'work-program' in education. Psychologically, the concept of 'doing' is by no means limited to overt muscular behavior, but may be exhibited in equally vigorous form in many kinds of abstract mental activity. As Guthrie has pointed out, even the process of listening may be an extremely active affair.

A second example of a clash of views arises from a reform centering around another slogan, namely, "The school should be like life." The contribution of this group has been to bring into the school allegedly 'lifelike' curricular units as contrasted with the usual school subjects. This has resulted in 'projects' of various kinds and under various names, but the essential purpose of all of them has been the same, namely, to elicit more vigorous responses from the learner. Psychologically, the aim has been good, and, in practice, some stimulating learning units have been introduced which have served to break down the formality of the older curriculum. Good projects to enrich and enliven a systematic curriculum encountered little opposition; in fact, their contribution was widely accepted and welcomed. The real issue in curriculum construction did not arise until the proposal was made that the entire curriculum should be organized as a series of lifelike projects or activities in place of a subject curriculum, which was essentially an attempt to present content in an organized and systematic way. As in the case of learning by doing, the clash between the subject-curriculum group and the 'life-situation' group has resulted in each side being pushed into positions so narrow as to be almost untenable. This issue of how the curriculum should be organized is one of the major problems before the school.

Psychologically there are merits in both the life-situation and the systematic-organization positions. Furthermore, they are supplementary, rather than mutually exclusive, concepts. It is only when either position wants a monopoly on the curriculum that trouble arises. The solution to the problem must be derived from some sensible, working relationship between the two concepts.

The life-situation curriculum claims to be superior in motivation—to produce more vigorous responses from the learner. Its proponents repeat the slogan that "schools should be like life" as though this were a self-evident truth. As a matter of fact, not all life situations are stimulating. Much of life is drab and routine, as much so as the duller parts of school subjects. Only a careful selection of life situations or projects will produce superior responses, and one cannot overlook the fact that published evidence has shown that most of the so-called life-situation projects are neither lifelike nor stimulating. Furthermore, it remains to be seen whether a continuous use of such situations can maintain interest.

There is, however, a more important defect in the life-situation program. It is by no means an established truth that schools should be lifelike. In fact, it is precisely because of the failure of ordinary life experience to produce a suitable education that schools are established. In essence, a school need make no pretense of being like life; its very strategy is in being superior to life. And its particular claim to superiority resides in the manner in which it has been able to organize and systematize life experience, not that of a single individual, but rather the significant experiences of the race. If the traditional subject curriculum has any defense, it lies in the superior advantage to the learner of systematized and organized content (of whatever kind) as compared with the concrete but very limited experiences of a single activity unit or project.

Therefore, the real problem is, first, to determine the relative merits of lifelike projects as compared with a systematically organized content, and, second, if merit should be found in both, to discover some means of retaining both values in a curriculum.

Sufficient experience with various types of activity, project, and problem curricula is now available to satisfy any unprejudiced observer that, where the activities are good and where the limitations of their use are recognized, they have produced superior results in terms of greater self-activity, increased interest, and vigorous responses, both mental and physical. They have been expensive processes in terms of time required, and they have not resulted so far in any sequential or organized series of units to cover the various levels of maturity. But they have, without question, enlivened many a dull curriculum. This much can have the full approval of a sound psychology of learning.

But a sound psychology of learning requires more than just vigorous responses of the learner. It is concerned also about the organization and reorganization of stimulating experiences. In fact, the principal trend in the psychology of learning for the last thirty years has been toward an *organization* of experiences as contrasted with a *summation* of experiences. Learning is at basis a continuous reorganization of experience. On this matter all theoretical positions are in agreement. All psychologies of learning, with some variation in terminology, emphasize the role of organized patterns of response, that is, responses which recognize relationships, configurations, wholes, meanings. A stimulus is not an atomistic, discrete, separate item; it is a part of a field, impinging on the learner as a complex perceptual pattern depending on

the range and focus of attention. Even the early 1912 statements of Thorndike's stimulus-response psychology recognized this, as indicated in Gates' quotation (p. 143):

> The situation or total state of affairs acting upon a human being would have to be defined as all the universe at the moment. . . . For, directly or indirectly, it all might count in determining his response. But for ordinary purposes it is allowable to leave out of consideration those features . . . which have no appreciable effect upon him.

Recent developments in the psychology of learning have served only to emphasize still more the relationships that enter into and constitute a given stimulus. The earlier view left out of consideration too many features on the ground that they had 'no appreciable effect' on the learner. Pavlov's bell sound was not the complete stimulus for his dog; it was the bell plus, or as a part of, the total situation in which it occurred. A pupil in school is stimulated by a given curriculum unit not as a discrete item, but as a related part of a field of experience which gives it meaning, provided the relationship is seen. Organization is a means of making relationships clear. As learning proceeds, these relationships broaden and interrelate into more meaningful patterns.

Both life-situation units and school subjects emphasize organization, although one stresses lateral and the other longitudinal organization. Furthermore, both life-situation units and school subjects suffer from certain narrow and limiting characteristics. If their strengths could be combined and their weaknesses eliminated, a sounder curriculum might result.

A life-situation project lays great emphasis upon lateral relationships. Such a project as building a ship affords an excellent opportunity to bring into a learning situation relationships of many kinds, both social and physical. It gives an opportunity, although with marked limitations, to employ abilities found in the ordinary subject curriculum, such as reading, writing, computing, etc. It affords many applications to life outside the school. It usually produces vigorous, active responses from pupils. All these characteristics are good. Within the pattern of organization included in the project, the learning situation is excellent. The difficulty lies in the fact that the project is not interrelated in any meaningful and systematic way with other projects which must follow under this plan for a curriculum. In relation to the entire range of a child's education, a project is only a magnified 'atom' appearing as one member of a discrete and unrelated series of such

units. The organization *within* the project may be, and often is, excellent; but the organization of many projects into a sequential and unified curriculum has not yet been approached. Nor has there appeared any great concern among proponents of the project curriculum as to how to escape this dilemma. They have been so much interested in the trees in each little plot that they have never looked over the forest. Educators who are concerned with the *whole* curriculum are justifiably worried over the disorganization and chaos that is displayed by the total program of some of the life-situation schools. The bright pupils in these schools succeed in developing some organization of experience in spite of the lack of it in the curriculum; but bright children show a surprising ability to do this without any schooling at all. A good curriculum should help the learner to continuously reorganize his experience into larger and more meaningful patterns. It is in relation to this large overview of education that the life-situation curriculum fails. Within the smaller units of content it may be excellent.

The subject curriculum also encounters difficulties in meeting the requirements of a sound psychology of learning. Its organization is highly developed in a longitudinal direction, but it is so lacking in latitudinal relationships as to warrant the frequently used designation of 'narrowly compartmentalized subject matter.' By and large this charge is all too true. The class in ancient history talks about events in a world which is seldom identified on a modern map. The physics of sound has no apparent relation to the scales used in a class in music. Literature may be taught with no appreciation of the social conditions or problems that have stimulated its writing, simply because the teacher of literature specialized in English and not in the social studies. Even the longitudinal organization which school subjects do exhibit is often based upon some logical or chronological basis which gives little aid to the learner. The one claim, and it is an important one, that the subject curriculum can emphasize is that it covers the knowledge in its field in a systematic and coherent fashion. The writer by no means shares the current contempt for knowledge which is exhibited by some curriculum makers. He can see no virtue in ignorance. Yet, the psychology of learning emphasizes the concept that we learn what we *do*; that the response is the important matter. And no one can deny that simply presenting subject matter, regardless of how well organized, frequently results in a docile passivity with no vigor of response and no evidence that the learner is 'doing' anything of consequence as a re-

sult of it. One very possible cause for this situation is the failure of the subject curriculum to develop those lateral relationships which would give meaning to the content of subjects.

The life-situation curriculum suffers from a failure to relate in any coherent fashion the successive projects which are connected by summation rather than interorganization. The subject curriculum suffers from a failure to give a lateral organization to subject matter which, within the individual subjects, possesses a high degree of organization and coherence.

In view of the many evidences of the value of organization in learning, it would seem that the time has arrived for curriculum makers to forego the pleasures of emotional excitement resulting from conflict between antagonistic groups organized to support this or that particular brand of curriculum, and to unite in a calm effort to develop a curriculum that will preserve the values and avoid the fallacies of the various divergent proposals. The purpose of a curriculum is to stimulate learning. A sound curriculum plan cannot be constructed on bases which violate a sound psychology of learning. There is enough agreement among various views in the psychology of learning to warrant a considerable amount of agreement among those holding different views of curriculum making. At least two generalizations of psychology are of sufficient breadth and importance to furnish an initial working basis. First, a curriculum must be such that it will motivate vigorous, active, 'doing' responses from the learner. Second, a curriculum must so emphasize organization that the successive experiences of the learner will be continuously related and interrelated into larger and more significant patterns—into increasing hierarchies of understanding. Responses must not be left as isolated entities.

Organization of experience always results in generalizations—principles, rules, laws. These generalizations are, in the very nature of the case, abstractions. They are of varying degrees of generality and become organized into succeeding hierarchies of understanding. Within a given subject, the systematic organization of content has so related the concrete items of experience, with which any subject begins, that they take on larger meanings and afford the learner increasing means of control. If one pursues any field of learning far enough, the interrelationships with other fields of knowledge pyramid into generalizations of universal truth, the attainment of which is the ultimate goal of learning. But at the school level, the limitations of understanding are

so severe that most pupils fail to see the relationships between subjects, and the systematic series of generalizations that is developed is limited to the subject itself. Consequently, the results of learning seem to have little relation to living. Not being able to see the relation of school subjects to life, the pupil loses interest in the subjects. Therefore, the proposal to abandon subjects and substitute life situations is attractive because of the possibility of securing better responses from pupils.

However, one would be blind to the facts to assume that subjects are always uninteresting. Some teachers have succeeded in developing a most lively interest in their subjects. The pattern of so doing is described clearly by psychology. In the beginning stages of understanding the learner is always concerned with the concrete aspects of experience. As learning proceeds, these concretes are related into larger patterns which make possible more meaningful experience. With more and more experience the relationships in the field emerge with greater clearness; they take form into organized patterns that fit into a broad, systematic relationship. As the pattern of understanding takes form the learner begins to develop mature interest in the field as contrasted to his original interest in individual concrete situations. This interest soon comes to be habitual and to be quite independent of the original situation which first motivated it. Any person can identify this developing process in any interest which has developed to a mature stage. Any boy's interest in model airplanes illustrates it equally well. At first he simply wants a plane that will fly. Then he wants it to fly faster and longer. Then, through comparing (relating) the flight of his plane to that of those of his friends, he wants to know how to improve the flight of his own. His interest now veers to the scientific; he wants some general knowledge, some principles that will direct him. Gradually he comes to be interested in technical aspects of aerodynamics and spends hours in reading 'abstract' material that provides a systematic and organized framework for his problem. His interest now is habitual and the time he devotes to 'concrete' flying of a plane is far less than the time he willingly gives to furthering his abstract understanding of aviation.

In his discussion of the nature of this process, Guthrie writes:

Most of the drives of school children and of adults are far removed from original annoyers and depend on learning. Any well-

> established habit directs behavior in the sense of motivating it, because habits become self-conserving in that interference with their execution acts as an annoyer and produces excitement and slight variation of the habit. The variation which permits the habit to be consummated or achieved tends to be preserved. The habit is preserved through changing to accommodate new conditions. When any routine has become habitual, interference with it is distressing (p. 47).

A project or an activity is an excellent curriculum unit at the introductory, concrete level of experience. It is successful up to the point where the learner has need for more abstract, generalized experience than is afforded by the 'lifelike' activity. Then the learner needs help superior to that which 'life' supplies. He needs the advantages of an organized, systematic formulation of the field in which his problem falls. This systematic organization is found in our science (using the term broadly); it is the intellectual heritage which is ours through the coöperation of those who have added, generation after generation, to our fund of general understanding. It is worse than folly—it is naive conceit—to assume that a curriculum can grow out of the concrete life experience of the present and disregard the organized patterns of understanding that previous learning has made available. Likewise, it is psychologically inexcusable for advocates of a systematic subject curriculum to assume that a beginning learner can be motivated by the mature abstractions that are the end-products of an organized content.

From the standpoint of psychology, certain aspects of the curriculum problem seem clear. The necessity of organization in learning is inescapable. Isolated experiences, be they mere facts or activities, have little value unless they are related within some significant pattern. The function of learning is so to enlarge one's general pattern of understanding that succeeding items of experience will find a place in the pattern and will take on meaning. An item becomes meaningful as it is related to its field. As the field becomes organized the relation of new items of experience is more readily understood. The school must further the general organization of this background of experience.

The place of organization in a curriculum, therefore, becomes apparent. There must eventuate an organized framework of content. This general content may be some improvement of the present subject curriculum or it may be an organized content quite different from our present school subjects. Whatever the organization, the content must include an abstraction of significant racial experience; it is the function

of educators, psychologists, sociologists, and others, to determine jointly what is significant.

Paralleling this significant, organized content (organized longitudinally), there must be an appropriate series of teaching units for introducing and motivating new general concepts. These units need lateral organization and should serve both to motivate and to interrelate the content of the organized framework. They must of necessity be selected to fit the needs of increasing maturity in the curriculum from grade to grade. Their longitudinal relationship will be determined by the general framework of the program, thereby preventing the repetition and lack of coherence that results from project or activity units formulated independently of each other.

This two-factor plan of curriculum development would serve several purposes. It would preserve the advantages of both systematic organization of content and excellent motivation through life situations. It would break down the present wasteful strife between curriculum groups whose views are actually supplementary rather than fundamentally opposed. It would recognize the requirements of a sound psychology of learning in properly relating concretes and generalizations, parts and wholes, and in viewing learning as a continuous process of reorganizing experience.

The proposed plan would also serve to resolve the present tempest in a teapot as to whether curricula should be determined by children's interests or by adult planning, or, as it is sometimes expressed, be determined democratically or autocratically. The place of the two factors in this dichotomy becomes clear in terms of the preceding discussion. The general longitudinal organization and content must obviously be formulated by those who are mature enough to see the place of an organized framework and whose own education has made them competent in their various fields. It is the job of experts. On the other hand, the formulation of suitable project or activity units can be done only through coöperation with pupils, at the appropriate level, so that the projects finally formulated will be actually motivating.

IV. Sequence in the Curriculum

The preceding discussion of organization has necessarily carried some implications in regard to sequence, since the very nature of organization requires some kind of sequential relationship. The problems here relate to possible kinds of sequence and the reasons for them.

Furthermore, there are questions that concern the internal arrangement of a given curriculum unit as compared with questions that apply chiefly to the sequence of major divisions of the entire curricular program.

The content of any curriculum consists of both concretes and generalizations, and the generalizations may be of varying order of generality. The relationships of parts and wholes has long been a source of controversy, particularly in regard to sequence. Should the parts or the whole come first? Does the whole consist of the sum of its parts? How many parts must be taught, and how frequently repeated, to assure a comprehension of the whole? Questions such as these often arise from misunderstanding the terminology of parts and wholes. Some confusion is due to the notion that there is one and only one correct sequence in learning.

Hartmann's statement, which follows, constitutes a good starting point. "Parts and wholes are never absolutes, every whole is a part to some larger whole, and every part is a whole to some smaller part" (p. 207). As a matter of fact the learning process proceeds in both directions; from parts to wholes and still larger wholes, as skills, concepts, and understandings are developed, and from wholes to parts when the general procedures that have been built up are applied to particular cases. However, discussion generally centers in the first part of this process.

To be effective, any curricular unit must have some general goal or objective toward which learning is directed. These goals are in themselves wholes of some degree of generality. They may be posed as problems or as concepts to be clarified. To this extent, learning proceeds from a whole to a study of parts. It must not be assumed, however, that such a statement of a goal or objective is in any sense a substitute for the goal to be attained. It is merely a directing overview, a skeleton to be filled in. When the goal is presented with sufficient clearness to motivate the learning, the process is then one of relating and organizing parts until the goal is actually achieved by the learner.

The question of how many parts or how many repetitions of a part are necessary to establish a concept of the whole, depends chiefly on the sequence and organization of the parts. Psychologists are now unanimous in agreeing that repetition alone does not establish learning. Neither does a multiplication of unrelated facts lead to significant

general patterns of understanding. Understandings depend on relationships. A curriculum may be built by simply stringing together a succession of facts or experiences (summation) or it may be built by a careful, coherent organization of facts or experiences leading to concepts of ever increasing generality. It is true that bright minds may see relationships in experiences presented with no organization, but one assumes that a curriculum is to aid, rather than to frustrate learning. The number of minds that are able to sense the concept of evolution is far greater since Darwin and his followers began to organize the data of common observation into a sequence that assists the learner to see this significant relationship.

There remains to be answered the question as to how many parts (facts, data, experiences) are needed to make the generalization (goal or objective) clear, but this question is subject to experimental answer and will vary according to conditions which can be defined. The main point is that good learning depends on a coherent sequential organization of a curriculum and that a mere summation of facts or experiences in random order will not satisfy. As Hartmann has pointed out, five facts taught with all their interrelations may result in more understanding of a given area than twenty equally important facts learned only as discrete experiences.

> The distinction between sheer frequency or amount of information about a problem and the focal grouping of such knowledge is the difference between ineffective and effective organization of material. One's contacts with the raw materials of educational psychology—or any other 'segregated' subject matter—should not be such that one cannot see the forest on account of the trees. Perspective comes as a result of sensitivity to interrelations . . . the only way to mount to higher and higher synthesis is to adopt and maintain a 'systematic' attitude of seeing events and properties in their togetherness rather than as isolated happenings in a 'rag-bag' universe (pp. 204-5).

Another aspect of the problem of sequence has to do with the retention of what is learned. As Guthrie has stated, "There is no conclusive evidence that the simple lapse of time causes anyone to forget anything" (p. 28). Forgetting is related chiefly to the inhibition or reinforcement that follows the learning. Consequently, the matter of sequence in a curriculum is a prime factor in insuring maintenance of learning. This is again a matter of relationships. Learning which is

followed by related learning is retained, is built into higher learning patterns.

Schools will have great difficulty in defending the sequence of their present curricula. Where curricula have been based on life situations there has been little pretense of concern for any coherent sequence. The few radical schools that 'let the children decide' the curriculum can obviously not expect a coherent content. Subject-matter curricula give less attention to the problem than it received a generation ago, partly because the elective system makes continuing control of sequence almost an impossibility. Yet, the psychology of learning points to coherent sequential relationships as a prime factor in any curriculum. There has been some evidence of increased concern about this problem in the last few years. For example, in the field of mathematics there has been considerable discussion of the desirability of sequential reorganization with deferment of some topics to higher grades. But so far, reorganization is more apparent in discussion than in practice.

Two other examples of the relation of sequence to the curriculum may be mentioned briefly. One of these is the adjustment of the curriculum to the maturity level of the learner, the so-called 'readiness' problem. Most of the attention to this has centered at the primary-grade level, although some work has also been done with the junior high school curriculum. The lack of adequate data and methods of determining the needs of different pupils at various stages of progress and in different curriculum areas is retarding progress in making readiness adjustments. Another example of serious work on curriculum sequence is found among those groups which are trying to develop 'general' or survey courses, particularly at the junior-college level. Their efforts probably represent the best available example of a real attempt to develop a curriculum unit with respect to both longitudinal and lateral relationships and with added concern for sequence. Such general courses have served to break down the barriers between subject compartments and to attempt to achieve broader (lateral) generalizations in respect to content.

V. Organization and Sequence as Related to Transfer

One of the important criteria of a sound curriculum is the degree in which it assists the learner to transfer or spread the results of learning to wider areas of experience. The opportunities in life for a *direct* carry-over of what is learned in school are patently so few that the

defense of any curriculum must be chiefly in terms of its transfer effect.

The theoretical chapters in this Yearbook are in agreement that transfer will not result from learning a multiplicity of separate, discrete items. So much discussion of transfer has in the past centered around Thorndike's concept of 'identical elements' that Gates gives special attention in his chapter to clarifying Thorndike's use of the term. According to Gates' interpretation, Thorndike is as ready to defend relationships and patterns in a curriculum as are the Gestaltists. A curriculum which facilitates transfer must emphasize relationships, insights, generalizations.

In exaggerated form, the issue here is whether a curriculum should consist in concretes or abstracts, facts or generalizations, practice or theory. Since no reader would take such an 'either-or' position, the question resolves itself into one of degree. What shall be the proportion of facts and generalizations, of concrete practice and abstract theory? Again, the final answers must be determined experimentally in a given case, but the general psychological principle that applies seems clear. Enough facts or concretes must be presented to make the generalization or theory or relationship clear. Additional specifics are superfluous; too few are likely to result in verbalisms, memorized but not understood. There are certain other aspects of the technique of transfer which are well known. The generalization (law, rule, principle, relationship) to be transferred must appear as a constant factor in a number of variable situations; it must be pointed out or emphasized in some manner so that the learner is aware of it; and there must be some practice in applying the generalization to new situations. As far as transfer of content is concerned, these are requirements which any properly organized curriculum can meet. Also, a curriculum may be so planned and presented that there will result a transfer of method (generalized habits) as well as of content.

The school-subject curriculum has sometimes failed to meet the requirements of transfer because of too great a proportion of abstractions. As a result, it has been memorized but not understood. At other times it has so emphasized mere facts that the learner has not sensed significant relationships which would transfer to wider areas of living. The life-situation curriculum is rich in concretes and in minor generalizations, but its lack of sequence and longitudinal organization prevents it from reaching significant generalizations. The remedy again

seems to be some carefully planned combination of the two approaches.

The psychology of learning has now developed a sufficient understanding of the techniques and possibilities of transfer to afford guiding principles to curriculum makers. Too many schoolmen still operate on the assumption that the problem of transfer disappeared when the concept of formal discipline exploded along with the doctrine of faculty psychology. At no other point does education show its immaturity so conspicuously or suffer so much as from this failure to see that some position on transfer is the very heart of the curriculum problem or of any theory of education.

VI. Relation of Curriculum to the Child

One further aspect of the curriculum problem as related to the psychology of learning must be recognized in this chapter. All three theoretical positions presented in the first part of this Yearbook have emphasized the complexity of stimulus-response patterns. Hull, in discussing conditioning, calls attention to the presence of extra or alien stimuli in a conditioned-response compound which may reduce the anticipatory potential. "Thus the irrelevant stimulations resulting from an emotional upset will usually interfere with the capacity of a child to recite or to write an examination, and may temporarily abolish this capacity" (p. 78). Thorndike has repeatedly referred to the complexity of a stimulus by his phrase "other things being equal." The basic concept of the field theorists emphasizes the wholeness of a situation, its field properties. Obviously one cannot consider the sole stimulus of a learning situation in school as 'a curriculum' or minor unit thereof. The child, his world, the total school environment are all a part of it. A growing recognition of this truth is impelling educators to a new study of child development and of sociological factors in the learning situation in order that a curriculum may be planned more wisely. It is true that much of this new effort is at present characterized by sentimentalism and lack of valid techniques. But the movement embodies the kernel of a significant idea and has important implications for the curriculum maker. A curriculum expert needs to be also a keen student of the psychology of the learner for whom the curriculum is planned.

VII. Summary

This chapter has emphasized the importance of organization and sequence in curriculum building. It has tried to show how all theo-

retical positions agree in supporting this concept. Also it has tried to indicate how the psychology of learning suggests a sound basis for uniting in supplementary fashion two opposing schools of thought in curriculum making. In doing this, separate consideration has been given to problems of (1) organization, (2) sequence, (3) transfer, and (4) curriculum-child relationships.

There are obviously other curricular problems which might have been treated in relation to the psychology of learning, had space permitted. Such questions as the possible and desirable scope of a curriculum must be answered in terms of how much learning can be carried on at a given time without confusing the learner. How many subjects or activities should a child carry at a given time? How far can a curriculum be enriched with profit? How much can be included in a given learning unit to be covered in a specified period of time? A curriculum must be planned with careful attention to rate of learning. The problem of emphasis in a curriculum is yet another example of a factor which is essentially psychological. The thoughtful reader will doubtless see many other ways in which the psychology of learning may contribute to a solution of curricular problems.

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